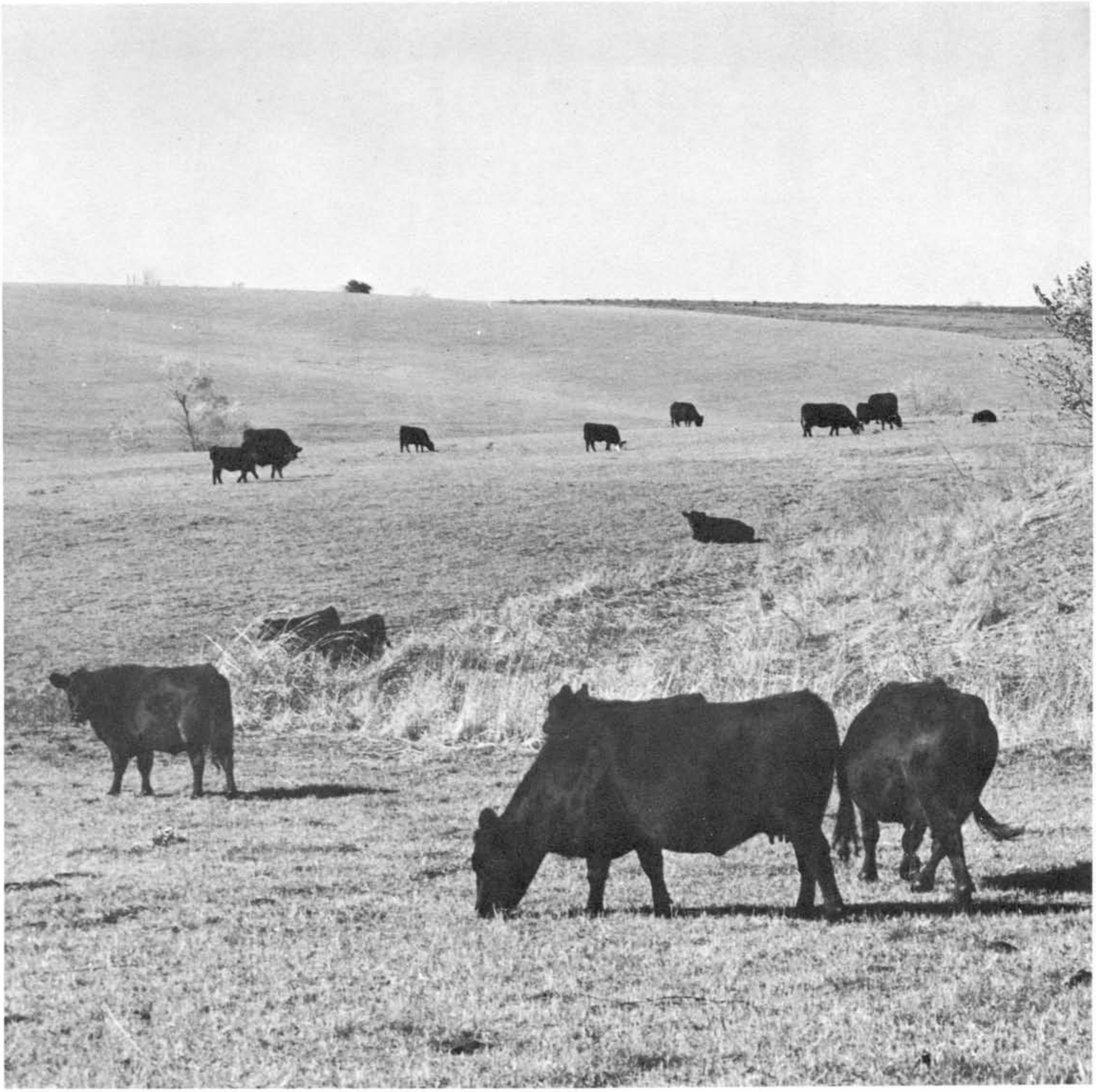
United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Missouri Agricultural
Experiment Station

Soil Survey of Gentry County Missouri



How To Use This Soil Survey

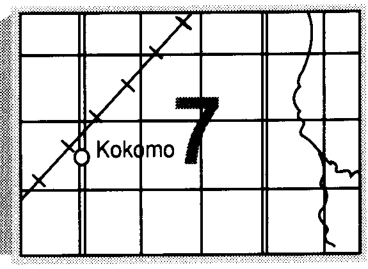
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

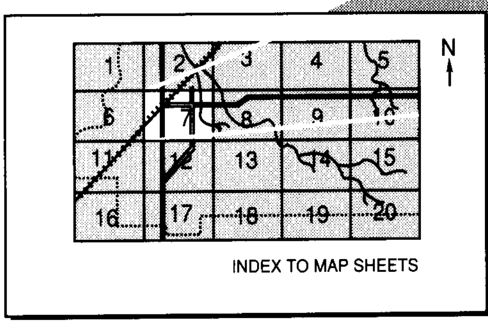
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



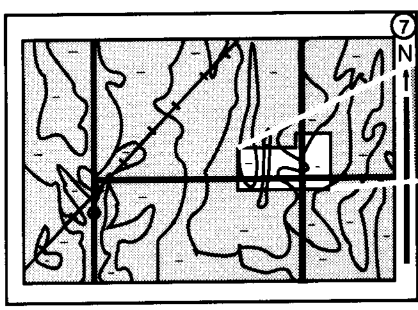
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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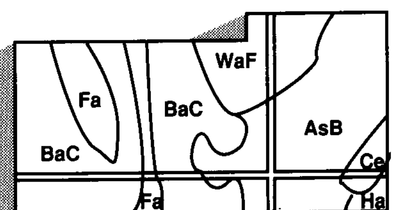

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. The Gentry County Soil and Water Conservation District provided funds for maps and supplies. This survey is part of the technical assistance furnished to the Gentry County Soil and Water Conservation District.

Major fieldwork for this soil survey was completed in 1981. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1980.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: A typical area in the Lamoni-Shelby association. Pasture is a major land use in Gentry County.

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Soil Series

Issued April 1985

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Gentry County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Paul F. Larson
State Conservationist
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Soil Survey of Gentry County, Missouri

By William R. Pauls, Soil Conservation Service

Fieldwork by William R. Pauls and Richard D. Douglas,
Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service
In cooperation with the Missouri Agricultural Experiment Station

Gentry County is in northwestern Missouri (fig. 1) in the Rolling Prairie. The total area of the county is 315,443 acres, or about 493 square miles. Albany is the county seat.

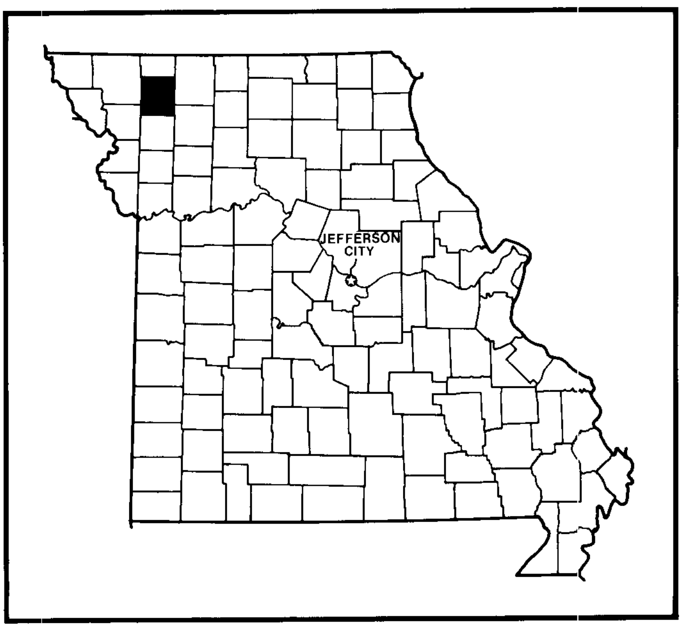

Figure 1.—Location of Gentry County in Missouri.

Farming is the main enterprise in Gentry County. Livestock, livestock products, and cash crops are the major sources of income. Most livestock enterprises raise beef cattle, hogs, dairy cattle, sheep, or chickens. The principal crops are corn, soybeans, wheat, grain sorghum, legumes, and grasses. Forested areas are mostly along the larger streams and rivers.

General Nature of the County

In this section, climate; water supply; physiography, relief, and drainage; history and development; and farming are discussed.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Gentry County consistently has cold winters and long, hot summers. Heavy rains occur mainly in spring and early in summer. The annual rainfall is normally adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Bethany, Missouri, in the period 1951 to 1979. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 28 degrees F, and the average daily minimum temperature is 17 degrees. The lowest temperature on record, which occurred at Bethany on January 12, 1974, is -29 degrees. In summer the average temperature is 75 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred at Bethany on July 17, 1954, is 108 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 36 inches. Of this, 25 inches, or 70 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 20 inches. The heaviest 1-day rainfall during the period of record was 6.09 inches at Bethany on October 11, 1973. Thunderstorms occur on about 56 days each year, and most occur in summer.

The average seasonal snowfall is 30 inches. The greatest snow depth at any one time during the period of record was 17 inches. On the average, 20 days per year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 55 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time possible in summer and 55 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in spring.

Tornadoes and severe thunderstorms occur occasionally but are local and of short duration. Damage varies and is spotty. Hailstorms occur during the warmer part of the year but only in small areas in an irregular pattern.

Water Supply

Sufficient water for domestic needs can be obtained in nearly two-thirds of Gentry County. Water yields seldom exceed 15 gallons per minute. Approximately 20,000 acres in Gentry County has good potential for development of irrigation wells, which can yield 200 to 1,000 gallons per minute. The most suitable areas for high-producing wells are in sand-and-gravel-filled channels and valleys of preglacial and interglacial streams *(4)*.

The major source of ground water is unconsolidated glacial deposits. The quality of the water from glacial drift generally is acceptable. Most of the water from glacial drift is high in total iron, total dissolved solids, and sulfates. The iron content in the water may cause staining of plumbing fixtures and laundry; however, relatively inexpensive water treatment for the iron will prevent this staining.

Water from consolidated rock formations which underlie Gentry County is generally mineralized. Moderately deep wells that reach into consolidated rock may yield limited amounts of water of marginal quality.

The streams of Gentry County, except for Grand River, flow intermittently. Water quality is satisfactory, but undependable flow makes the rivers unsuitable as a source of water for irrigation or for municipal use.

Most soils on the uplands in Gentry County are suitable for ponds and small lakes that can supply water for household purposes and livestock.

Physiography, Relief, and Drainage

Most of Gentry County is gently undulating to hilly uplands. The Grand River has formed a flood plain 1/2 mile to 2 miles wide that extends across the greater part of the county. It consists of three forks: West, Middle, and East. These join south and west of Albany and continue south-southeasterly out of the county. Numerous smaller streams and tributaries provide drainage for the county. The Platte River Slope begins in the extreme southwestern part of the county.

The elevation ranges from approximately 780 feet in the southeastern part of the county to nearly 1,100 feet in the northwestern corner.

History and Development

The first settlers came to what is now Gentry County about 1834 mainly from Kentucky, Virginia, and Tennessee. Gentry County was established in 1841 and fully organized in 1845. It is named for General Richard Gentry of the Missouri Militia. Albany, the county seat, was laid out in 1845 and was briefly called Athens. Stanberry, the second largest town in the county, was laid out in 1879. Other towns include King City, the bluegrass seed center, McFall, Darlington, Gentry, and Ford City.

About 60,000 acres of scattered groves and forests provided the early settlers with timber for shelter, fuel, building, and implements. The great quantity of native grasses provided pasture and hay. Deer, turkey, grouse, pheasant, and fish were plentiful. In the good growing climate, with sufficient rainfall and responsive soil, livestock production and crop production were abundant.

The population of Gentry County in 1890 was 18,909, and it reached a peak of 20,554 in 1900. Since then, it has steadily declined to 8,060 in 1970.

The first railroad reached Albany in 1879. U.S. Highway 169 is the major north-south transportation route, and U.S. Highway 136 is the main east-west route.

About 1900, cropping became more general, and erosion began to be a problem on the sloping soils. By 1930, erosion was a serious problem. In September 1944, after enactment of soil conservation district legislation, the Gentry County Soil and Water Conservation District was organized.

Farming

Agriculture has made up a sizable part of the life and economy of Gentry County.

The number of farms has decreased steadily from 2,699 in 1900 to 1,032 in 1978, with the average farm size going from about 120 acres in 1900 to approximately 288 acres in 1978. Twenty percent of the farms are operated by tenants. About 300 of the farms are operated by part-time farmers.

In 1969 about 43 percent of Gentry County was cropland, 35 percent was permanent pasture and hayland, and 13 percent was woodland. Livestock and related products accounted for about 72 percent of farm income in 1969 *(12).*

The general trend in farming since 1955 has been to larger farms, fewer farmers, and increased use of fertilizer, chemicals, and large machinery.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas called associations that have a distinctive pattern of soils, relief, and drainage. Each association on the general soil map is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The soils in the survey area vary greatly in their potential for major land uses.

Some of the boundaries on the soil maps of Gentry County do not match those on the soil maps of adjacent counties, and some of the soil names and descriptions do not fully agree. The differences are a result of improvements in the classification of soils, particularly modification or refinements in soil series concepts. Also,

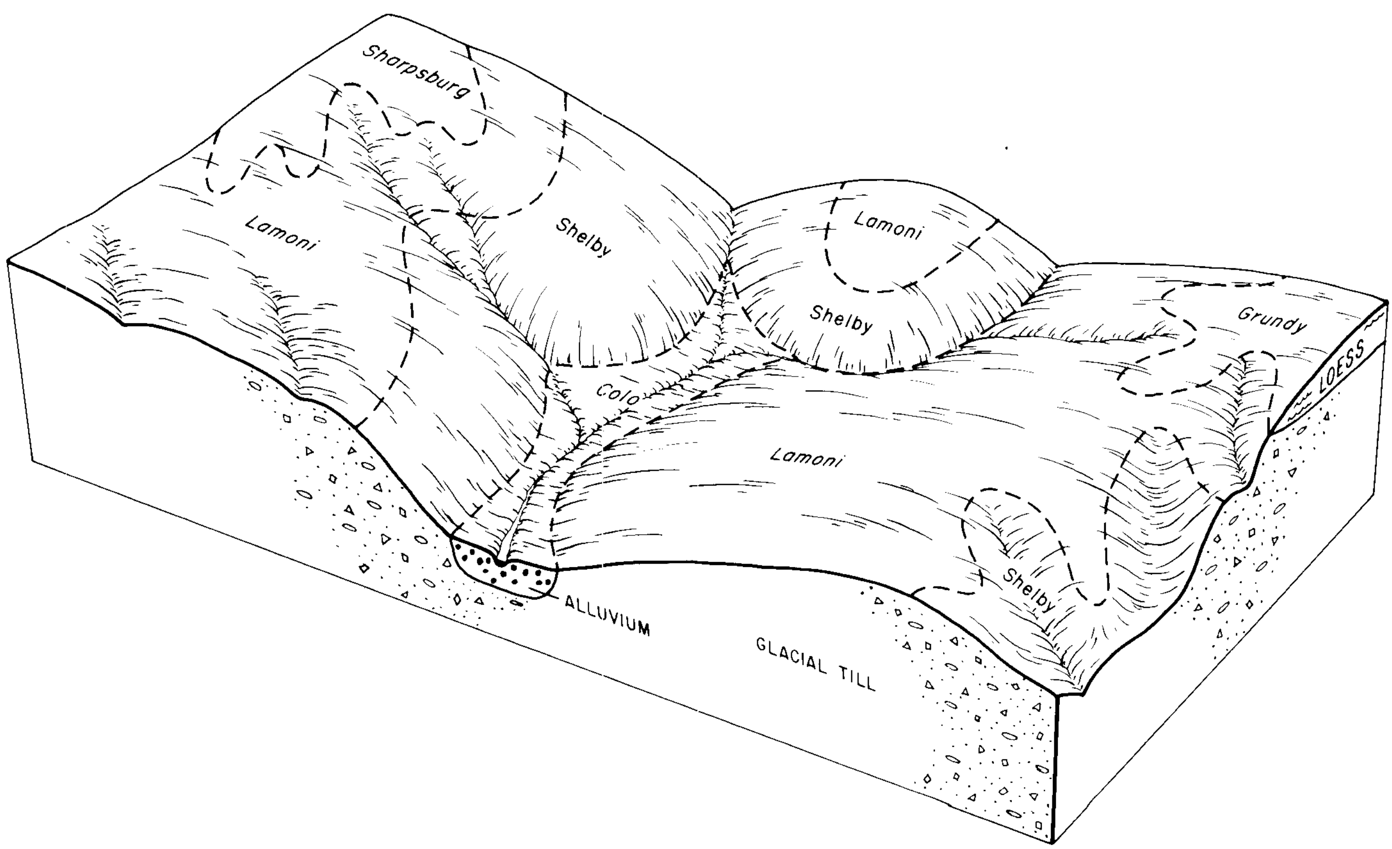

Figure 2.—Relationship of soils, topography, and underlying material in the Lamoni-Shelby association.

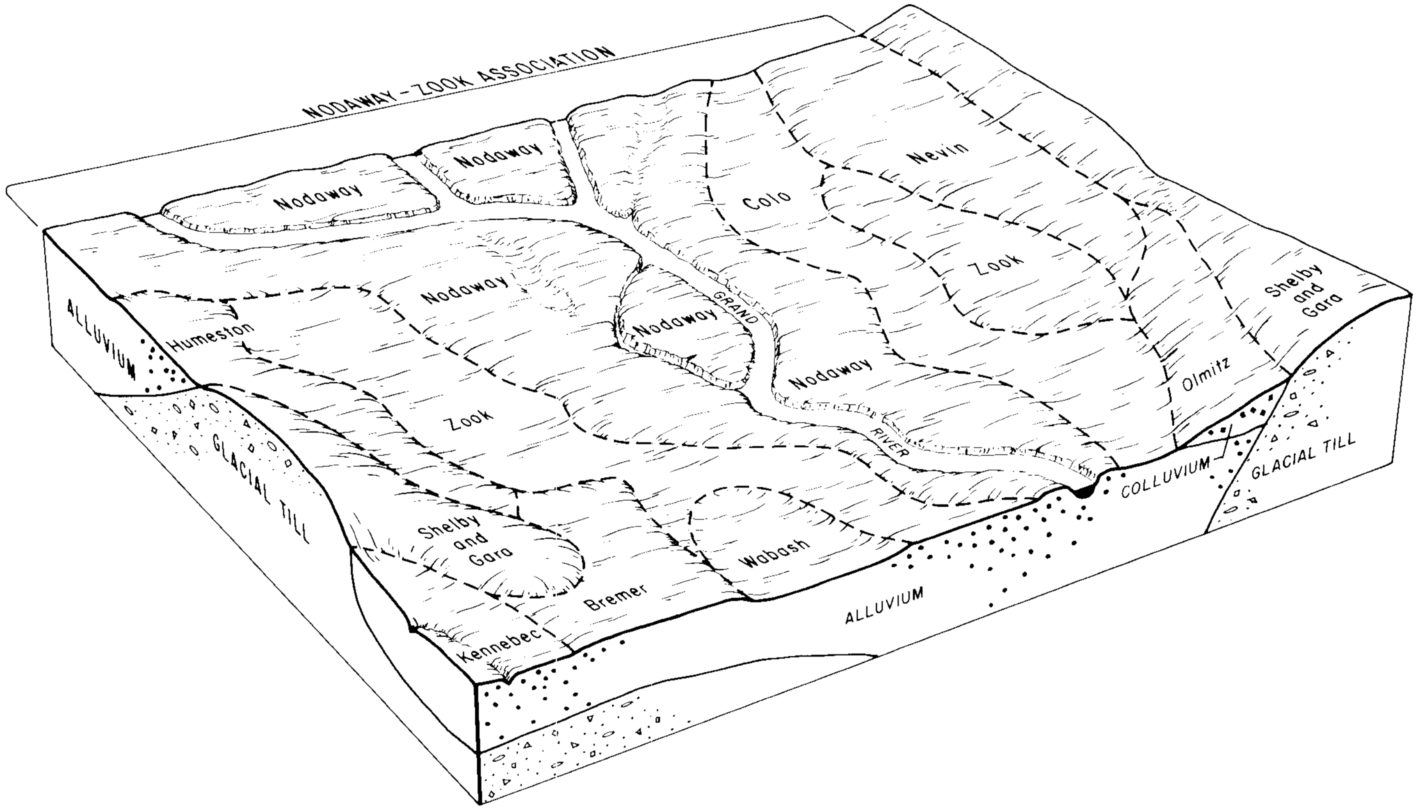

Figure 3.—Relationship of soils, topography, and underlying material in the Nodaway-Zook association.

there may be differences in the intensity of mapping or in the extent of the soils within the survey area.

1. Lamoni-Shelby Association

Deep, moderately sloping to moderately steep, somewhat poorly drained and moderately well drained soils that formed in glacial till; on uplands

This association consists of soils on narrow ridgetops and on long complex side slopes (fig. 2). This association makes up about 52 percent of the county. It is about 57 percent Lamoni soils and similar soils and 36 percent Shelby soils and similar soils. The rest is minor soils.

Lamoni soils are moderately sloping and somewhat poorly drained. They are on the top and sides of narrow ridges. Typically, the surface layer is black, friable loam. The subsurface layer is very dark grayish brown, friable clay loam. The subsoil is dark grayish brown, mottled, firm and very firm clay in the upper part; the middle part is mottled yellowish brown and grayish brown, very firm clay; and the lower part is yellowish brown, mottled, firm clay loam. The substratum is gray, mottled, firm clay loam.

Shelby soils are strongly sloping and moderately steep and are moderately well drained. They are on side slopes. Typically, the surface layer is very dark gray, friable loam. The subsurface layer is very dark grayish brown, friable clay loam. The subsoil is dark brown and brown, firm clay loam in the upper part and yellowish brown, mottled, firm clay loam in the lower part. The substratum is yellowish brown and olive, mottled, firm clay loam.

The minor soils are poorly drained Arbela and Humeston soils on low stream terraces; poorly drained Colo soils on narrow flood plains; moderately well drained Sharpsburg soils on wider ridges; and Grundy soils, which are similar to Lamoni soils. Sharpsburg soils have less clay than Lamoni soils and more clay than Shelby soils.

Many areas of this association are used for crops. The soils on most ridgetops and on the upper side slopes of most ridges, those on some lower side slopes, and those on some narrow bottom lands are suited to corn, soybeans, grain sorghum, and wheat. Controlling erosion and improving or maintaining fertility and tilth are the major concerns in management for crops.

Many areas of this association are used for hay and pasture. Grasses and legumes grow well and are effective in controlling erosion. Overgrazing leads to erosion. In most areas, ponds provide water for livestock.

This association is suitable for building sites and most sanitary facilities. The major management concerns are shrink-swell potential, slope, and wetness.

2. Nodaway-Zook Association

Deep, nearly level, moderately well drained and poorly drained soils that formed in alluvium; on flood plains

This association consists of soils on medium and large flood plains (fig. 3). In much of this association the rivers were straightened in the early 1900's, leaving abandoned channels. Some of the abandoned channels have been reclaimed for agricultural use. This association makes up about 18 percent of the county. It is about 45 percent Nodaway soils and 30 percent Zook soils and similar soils. The rest is minor soils.

Nodaway soils are nearly level and moderately well drained. They are on flood plains adjacent to river and stream channels. Typically, the surface layer is very dark grayish brown, friable silt loam. The substratum is stratified very dark gray, very dark grayish brown, dark grayish brown, grayish brown, and brown, friable silt loam.

Zook soils are nearly level and poorly drained. They commonly are some distance from the river or stream channel in low and slack-water areas on the flood plain. Typically, the surface layer is black, friable silty clay loam. The subsurface layer is black, friable and firm silty clay loam and silty clay. The subsoil is very dark gray, firm silty clay. The substratum is dark gray, mottled, firm silty clay.

The minor soils are poorly drained Bremer and Humeston soils on low stream terraces; moderately well drained Kennebec soils adjacent to the river and stream channels; somewhat poorly drained Nevin soils; gently sloping Olmitz soils on foot slopes; and Colo and Wabash soils, which are similar to Zook soils. Bremer and Humeston soils have a dark surface layer less than 36 inches thick. Kennebec soils have a thick dark surface layer. There are also some small sandy areas near river channels.

Most areas of this association are used for crops. These soils are suited to corn, soybeans, grain sorghum,

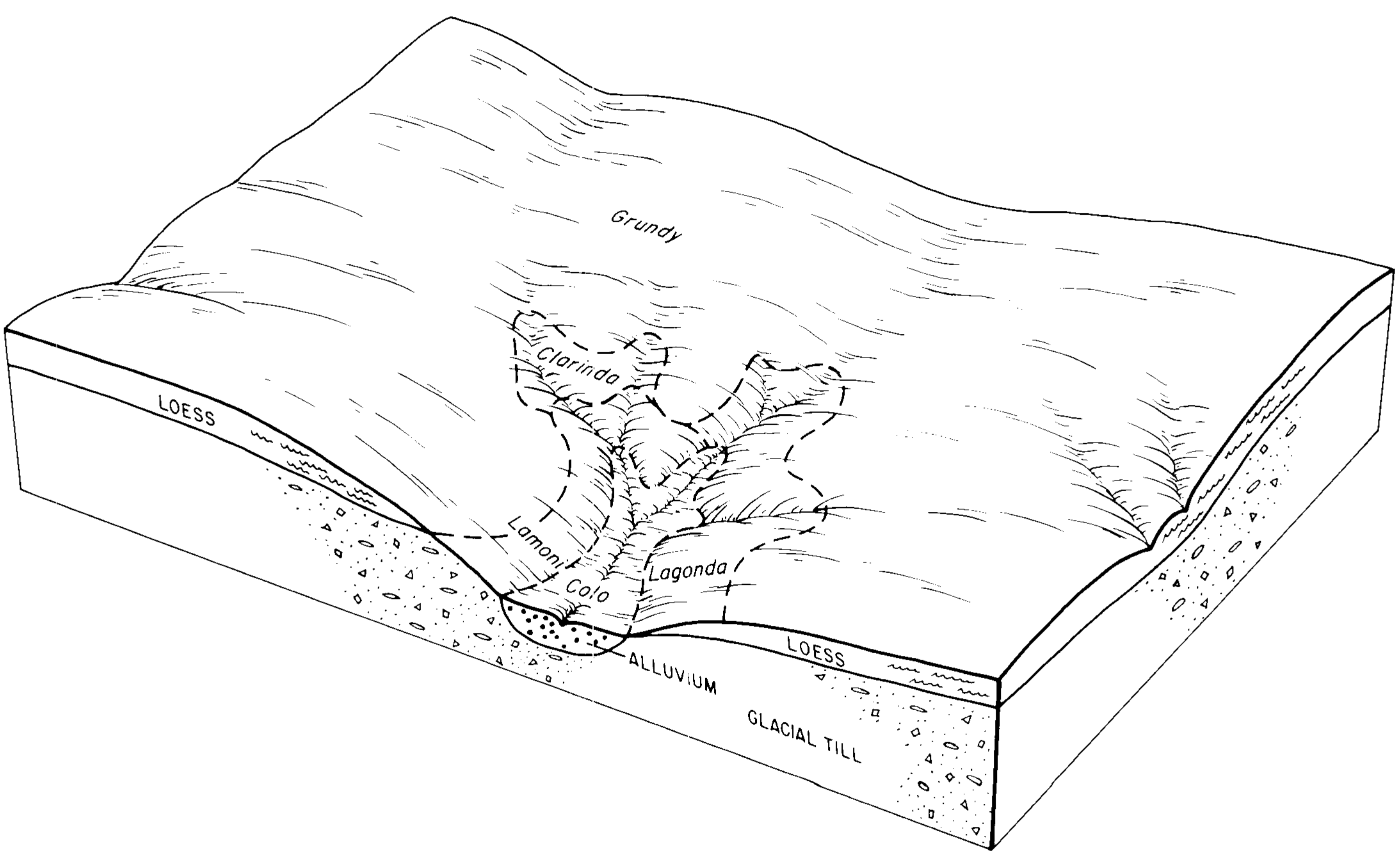

Figure 4.—Relationship of soils, topography, and underlying material in the Grundy association.

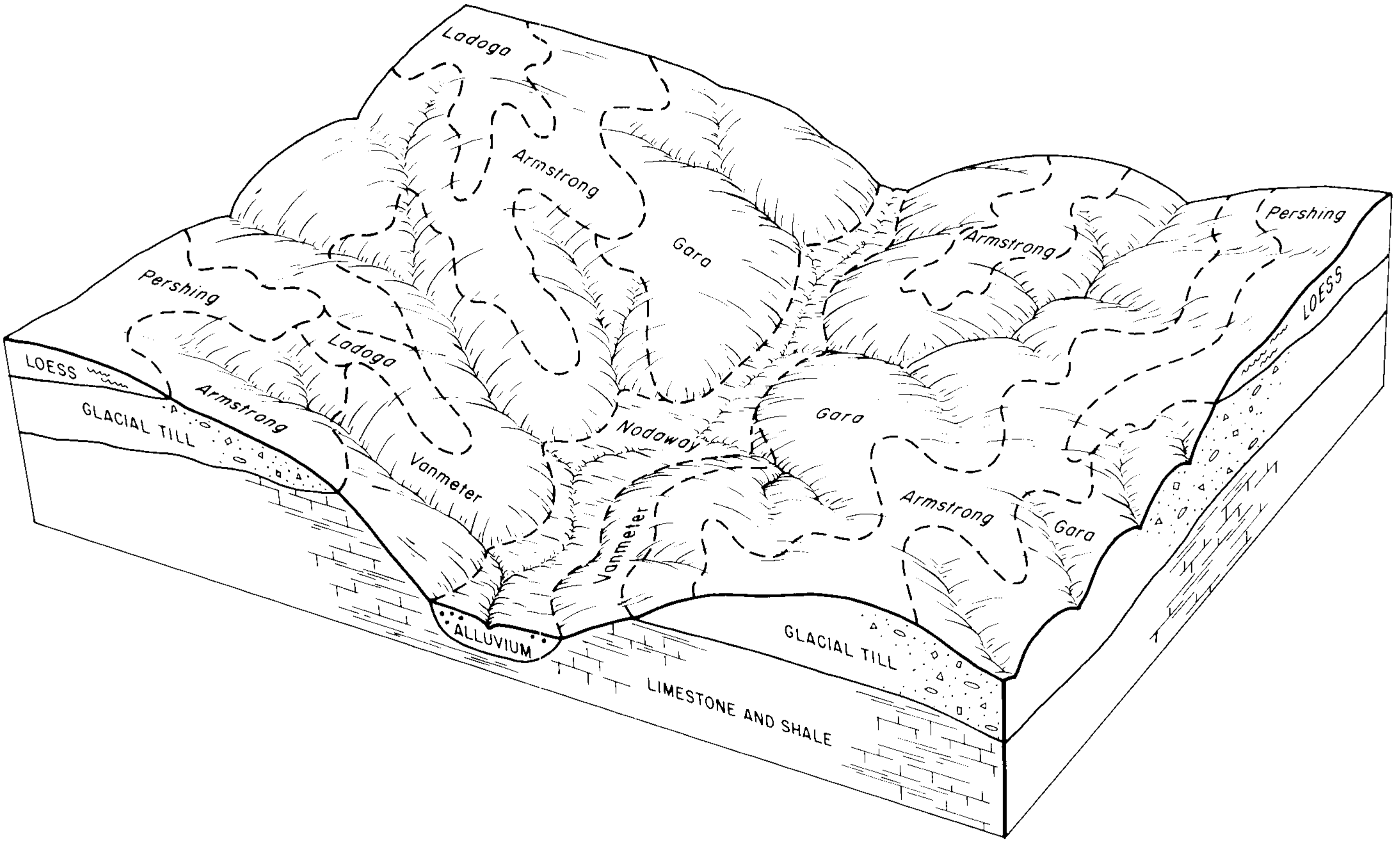

Figure 5.—Relationship of soils, topography, and underlying material in the Gara-Armstrong-Vanmeter association.

and small grains. Flooding and wetness are the major management concerns.

A few areas of this association are used for hay and pasture. These soils are suited to grasses and some legumes. Flooding and wetness are the major management concerns.

This association generally is unsuitable for building sites and sanitary facilities because of the flooding.

3. Grundy Association

Deep, gently sloping and moderately sloping, somewhat poorly drained soils that formed in loess; on uplands

This association consists of soils on wide ridges and on long side slopes (fig. 4). This association makes up about 15 percent of the county. It is about 96 percent Grundy soils and similar soils. The rest is minor soils.

Typically, the surface layer of Grundy soils is black, friable silt loam. The subsurface layer is black, friable silty clay loam. The subsoil is very dark grayish brown, mottled, firm silty clay loam in the upper part; the middle part is dark grayish brown, mottled, firm silty clay; and the lower part is grayish brown, mottled, firm silty clay and silty clay loam. The substratum is grayish brown, mottled, firm silty clay loam.

The minor soils of this association are poorly drained Colo soils on narrow flood plains; poorly drained Clarinda soils at the head of drainageways; and Lagonda and Lamoni soils, which are similar to Grundy soils.

Many areas of this association are used for crops. These soils are suited to corn, soybeans, grain sorghum, and small grains. Erosion and spring wetness are the major management concerns.

Many areas of this association are used for hay and pasture. Grasses and legumes grow well and are effective in controlling erosion. Overgrazing leads to erosion. In most areas, ponds provide water for livestock.

This association is suitable for building sites and some sanitary facilities. The major management concerns are shrink-swell potential, wetness, slow permeability, and slope.

4. Gara-Armstrong-Vanmeter Association

Deep and moderately deep, moderately sloping to very *steep, moderately well drained and somewhat poorly drained soils that formed in glacial till or residuum of shale; on uplands*

This association consists of soils on narrow ridgetops and on highly dissected side slopes that are adjacent to the larger streams and rivers (fig. 5). These soils formed primarily under forest. This association makes up about 15 percent of the county. It is about 40 percent Gara soils and similar soils, 33 percent Armstrong soils and similar soils, and 13 percent Vanmeter soils. The rest is minor soils.

Gara soils are deep, strongly sloping and moderately steep, and moderately well drained. They are on side slopes. Typically, the surface layer is very dark grayish brown, very friable loam. The subsurface layer is grayish brown, very friable loam. The subsoil is brown and dark yellowish brown, firm clay loam in the upper part; the middle part is dark yellowish brown, mottled, firm clay loam; and the lower part of the subsoil and the substratum are yellowish brown, mottled, firm clay loam.

Armstrong soils are deep, moderately sloping, and somewhat poorly drained. They are on the top and upper sides of narrow ridges. Typically, the surface layer is very dark grayish brown, friable loam. The subsurface layer is brown, friable loam. The subsoil is dark yellowish brown, mottled, firm clay loam in the upper part; the middle part is brown and strong brown, mottled, firm clay; and the lower part is strong brown and yellowish brown, mottled, firm clay loam.

Vanmeter soils are moderately deep, moderately steep to very steep, and moderately well drained. They are on side slopes. They have limestone flagstones scattered over the surface and in the upper part of the soil. Typically, the surface layer is friable flaggy silty clay loam; it is very dark gray in the upper part and dark grayish brown in the lower part. The subsoil is brown and olive brown, firm silty clay in the upper part; the lower part is grayish brown, firm silty clay. The substratum is grayish brown, very firm soft clay shale.

The minor soils of this association are nearly level, poorly drained Arbela and Humeston soils on low stream terraces; Ladoga soils on higher, narrow ridgetops; nearly level Nodaway soils on flood plains; and Pershing soils, which are similar to Armstrong soils. Ladoga soils contain less sand and pebbles than Gara and Armstrong soils.

Most areas of this association are in trees or wooded pasture. The soils are suited to trees. The major management concerns are erosion when ground cover is removed during planting and harvesting, the difficulty in using equipment because of the steep slopes, coarse fragments and rock outcrops, seedling mortality, and windthrow.

Some areas of this association are used for hay and pasture. Most grasses and legumes grow well and effectively control erosion. Overgrazing leads to erosion. In most areas, ponds provide water for livestock.

Vanmeter soils generally are unsuitable for building sites and most sanitary facilities because of slope, depth to rock, and shrink-swell potential. Gara and Armstrong soils are suitable for building sites and sanitary facilities. The major management concerns are shrink-swell potential, slope, slow permeability, and wetness.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of the soil for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Shelby loam, 9 to 14 percent slopes, is one of several phases in the Shelby series.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

6B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This soil is on ridgetops. It is gently sloping and moderately well drained. The individual areas are long and narrow and range from 10 acres to over 200 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick. The subsurface layer is very dark brown, friable silty clay loam about 8 inches thick. The subsoil is about 42 inches thick. The upper part of the subsoil is brown, firm silty clay loam; the middle part is brown and dark yellowish brown, mottled, firm silty clay loam; and the lower part is grayish brown, mottled, firm silty clay loam. The substratum is grayish brown, mottled, firm silty clay loam to a depth of 60 inches or more. In some eroded areas, the combined thickness of the dark surface and subsurface layers is less than 10 inches. In small areas, this soil has sand and small pebbles in the lower part of the subsoil.

Included with this soil in mapping are a few small areas of somewhat poorly drained Grundy soils. These soils generally are lower on side slopes and ridge ends and make up about 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of erosion if the soil is cultivated continuously. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Overgrazing reduces future production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced to prevent structural damage by the shrinking and swelling of the soil. Septic tank filter fields generally function properly if the length of the laterals is increased to compensate for the moderately slow permeability. Properly designed sewage lagoons work well if slowly permeable material is used to seal the bottom and sides. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by the low strength of the soil, frost action, and shrinking and swelling.

The land capability classification is IIe.

10C2—Lagonda silty clay loam, 5 to 9 percent slopes, eroded. This soil is on the top and upper side slopes of ridges. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark gray, friable silty clay loam about 6 inches thick. The mottled subsoil is about 45 inches thick. The upper part of the subsoil is dark grayish brown, firm silty clay loam; the middle part is dark grayish brown, firm silty clay and silty clay loam; and the lower part is gray, firm clay loam. The substratum is grayish brown, very firm clay to a depth of 60 inches or more. In some areas, the dark surface layer is more than 10 inches thick. In some areas, the soil contains less than 5 percent sand throughout. In some other areas, the soil has pebbles in the upper part of the subsoil.

Included with this soil in mapping are some areas where the soil is severely eroded and the present surface layer is mostly subsoil material. These areas make up about 5 percent of the map unit.

Permeability is slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is low. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1.5 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of further erosion if this soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too small or narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IIIe.

11B—Grundy silt loam, 2 to 5 percent slopes. This soil is on narrow to broad ridgetops, upper side slopes, and high terraces. It is gently sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 10 acres to more than 500 acres in size.

Typically, the surface layer is black, friable silt loam about 6 inches thick. The subsurface layer is black, friable silty clay loam about 6 inches thick. The mottled subsoil is about 38 inches thick. The upper part of the subsoil is very dark grayish brown, firm silty clay loam;

Figure 6.—Harvesting soybeans on Grundy silt loam, 2 to 5 percent slopes.

the middle part is dark grayish brown, firm silty clay; and the lower part is grayish brown, firm silty clay and silty clay loam. The substratum is grayish brown, mottled, firm silty clay loam to a depth of 60 inches or more. In some eroded areas, the combined thickness of the dark surface and subsurface layers is less than 10 inches.

Included with this soil in mapping are a few small areas of moderately well drained Sharpsburg soils. These soils generally are in high convex areas on the ridges and make up about 5 percent of the map unit.

Permeability is slow, and surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans (fig. 6), grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Most areas are smoothly sloping and large enough to be terraced and farmed on the contour. Some areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced and backfilled with sand or gravel to prevent structural damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material helps to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IIe.

11C—Grundy silt loam, 5 to 9 percent slopes. This soil is on side slopes in the upper parts of drainageways and on narrow ridgetops. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 5 acres to more than 100 acres in size.

Typically, the surface layer is black, friable silt loam about 9 inches thick. The subsurface layer is very dark grayish brown, firm silty clay loam about 2 inches thick. The mottled subsoil is about 31 inches thick. The upper part of the subsoil is dark grayish brown, firm silty clay; the middle part is grayish brown, firm silty clay; and the lower part is grayish brown, firm silty clay loam. The substratum is grayish brown, mottled, firm silty clay loam to a depth of 60 inches or more. In some eroded areas the combined thickness of the dark surface and subsurface layers is less than 10 inches. In small areas, the soil has sand and small pebbles in the lower part of the subsoil.

Permeability is slow, and surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of erosion if this soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around the footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IIIe.

12B2—Grundy silty clay loam, 2 to 5 percent slopes, eroded. This soil is on side slopes in the upper part of drainageways. It is gently sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 5 acres to more than 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 6 inches thick. The mottled subsoil is about 34 inches thick. The upper part of the subsoil is dark grayish brown, firm silty clay loam; the middle part is dark grayish brown, firm silty clay; and the lower part is grayish brown, firm silty clay and silty clay loam. The substratum is grayish brown, mottled, firm silty clay loam to a depth of 60 inches or more. In some areas, the dark surface layer is more than 10 inches thick. In other small areas, the soil has sand and small pebbles in the lower part of the subsoil.

Included with this soil in mapping are a few areas where the soil is severely eroded and the present surface layer is mostly subsoil material. These areas make up about 5 percent of the map unit.

Permeability is slow, and surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is low. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of further erosion if this soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IIIe.

12C2—Grundy silty clay loam, 5 to 9 percent slopes, eroded. This soil is on side slopes in the upper part of drainageways. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 10 acres to over 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 7 inches thick. The mottled subsoil is about 40 inches thick. The upper part of the subsoil is dark grayish brown, firm silty clay; the middle part is grayish brown, firm silty clay; and the lower part is olive gray and dark gray, firm silty clay loam. The substratum is grayish brown, mottled, firm silty clay loam to a depth of 60 inches or more. In some places, the dark surface layer is more than 10 inches thick. In some areas, sand and small pebbles are in the lower part of the subsoil.

Included with this soil in mapping are a few severely eroded areas in which the present surface layer is mostly subsoil material. These areas make up about 5 percent of the map unit.

Permeability is slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is low. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of further erosion if this soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Most areas are smoothly sloping and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IIIe.

13C2—Clarinda silty clay loam, 5 to 9 percent slopes, eroded. This soil is on side slopes at the heads of drainageways. It is moderately sloping and poorly drained. The individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is black and very dark gray, friable and firm silty clay loam about 9 inches thick. The subsoil is gray, mottled, very firm clay to a depth of 60 inches or more. In some areas, the surface layer is more than 10 inches thick.

Included with this soil in mapping are a few small areas of somewhat poorly drained Lamoni soils. These soils generally are lower on the side slopes and make up about 5 percent of the map unit.

Permeability is very slow, and surface runoff is rapid. Available water capacity and organic matter content are moderate. Natural fertility is low. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet, and tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture. The exposed subsoil is often called gumbotil. It usually does not provide enough moisture for good crop growth during dry summer months.

This soil is suited to hay and pasture. Row crops and small grains can be grown only on a limited basis in rotation using contour farming. There is a hazard of further erosion if this soil is cultivated. Contour farming, conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Deep tillage in fall improves tilth and internal drainage and allows earlier planting in spring. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IVe.

14C—Lamoni loam, 5 to 9 percent slopes. This soil is on ridgetops and upper parts of side slopes. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 10 acres to over 100 acres in size.

Typically, the surface layer is black, friable loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable clay loam about 5 inches thick. The subsoil is about 41 inches thick. The upper part of the subsoil is dark grayish brown, mottled, firm and very firm clay; the middle part is mottled yellowish brown and grayish brown, very firm clay; and the lower part is yellowish brown, mottled, firm clay loam. The substratum is gray, mottled, firm clay loam to a depth of 60 inches or more. In some eroded areas, the combined thickness of the dark surface and subsurface layers is less than 10 inches. In some areas this soil has less sand and small pebbles in the upper part of the subsoil.

Included with this soil in mapping are a few small areas of moderately well drained Shelby soils. These soils generally are lower on the side slopes and make up about 5 percent of the map unit.

Permeability is slow, and surface runoff is medium. The available water capacity is moderate. Natural fertility is medium, and the organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness grow well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing by livestock. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building site development and some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, low soil strength, and frost action.

The land capability classification is IIIe.

15C2—Lamoni clay loam, 5 to 9 percent slopes, eroded. This soil is on ridgetops and upper side slopes. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 10 acres to over 200 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The mottled subsoil is about 48 inches thick. The upper part of the subsoil is dark grayish brown, firm clay; the middle part is grayish brown and light brownish gray, very firm clay; and the lower part is light olive gray, firm clay loam. The substratum is grayish brown, mottled, firm clay loam to a depth of 60 inches or more. In some areas, the surface layer is more than 10 inches thick. In some areas the soil has less sand and pebbles in the upper part of the subsoil.

Included with this soil in mapping are some areas where the present surface layer is mostly subsoil material. Also included are a few small areas of moderately well drained Shelby soils. These soils generally are lower on the steeper side slopes. Included areas make up about 15 percent of the map unit.

Permeability is slow, and surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture (fig. 7).

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of further erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Most areas are smoothly sloping and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, low strength, and frost action.

The land capability classification is IIIe.

16D—Shelby loam, 9 to 14 percent slopes. This soil is on side slopes adjacent to narrow convex ridgetops. It is strongly sloping and moderately well drained. The individual areas are irregular in shape and range from 5 acres to over 200 acres in size.

Typically, the surface layer is very dark gray, friable loam about 7 inches thick. The subsurface layer is very dark grayish brown, friable clay loam about 5 inches thick. The subsoil is about 21 inches thick. The upper part of the subsoil is dark brown and brown, firm clay loam; and the lower part is yellowish brown, mottled, firm clay loam. The substratum is yellowish brown and olive, mottled, firm clay loam to a depth of 60 inches or more. In some eroded areas, the combined thickness of the dark surface and subsurface layers is less than 10 inches.

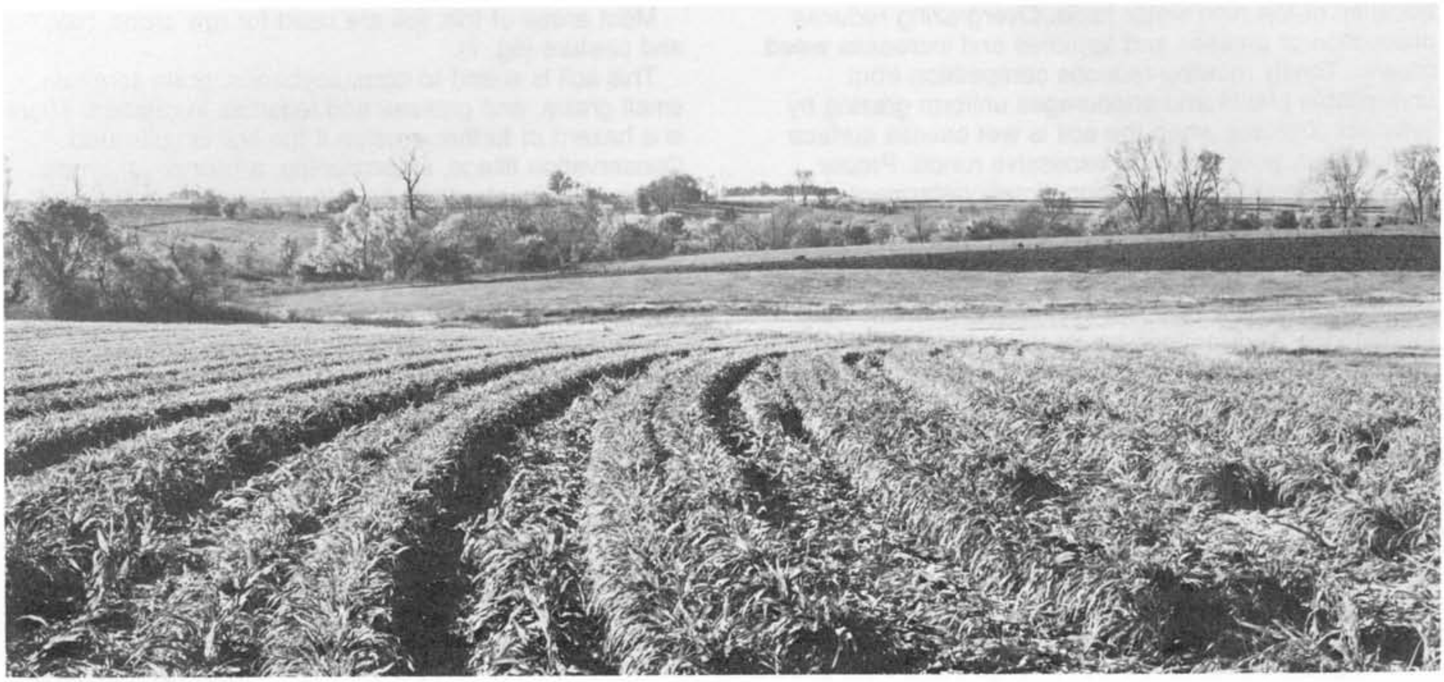

Figure 7.—Contour-planted grain sorghum after harvest in the foreground and pasture being plowed in the background; Lamoni clay loam, 5 to 9 percent slopes, eroded.

Included with this soil in mapping are a few small areas of somewhat poorly drained Lamoni soils. These soils generally are on the upper part of side slopes and make up about 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is medium. The available water capacity is high. Natural fertility is medium, and the organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential is moderate.

Most areas of this soil are used for hay and pasture.

Row crops and small grains should be rotated with close-growing pasture or hay crops. There is a hazard of erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are suited to terracing and contour farming. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Grasses and legumes grown for pasture and hay effectively control erosion. In establishing or reseeding grasses and legumes, minimum tillage helps to prevent excessive soil loss. Seed should be planted early enough for good ground cover to be established before the end of the growing season. A nurse crop can be planted to provide cover in late fall and winter until grasses and legumes are established. Adequate stands of grasses and legumes control runoff. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for use as building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Dwellings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage caused by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IIIe.

16E—Shelby loam, 14 to 20 percent slopes. This soil is on the lower part of side slopes adjacent to narrow convex ridgetops. It is moderately steep and moderately well drained. The individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is black, friable loam about 7 inches thick. The subsurface layer is very dark gray and very dark grayish brown, friable loam and clay loam about 9 inches thick. The subsoil is dark yellowish brown, firm clay loam about 20 inches thick. The substratum is yellowish brown, light yellowish brown, and light olive gray, mottled, calcareous, firm clay loam to a depth of 60 inches or more. In some eroded areas, the combined thickness of the dark surface and subsurface layers is less than 10 inches.

Permeability is moderately slow, and surface runoff is rapid. The available water capacity is high. Natural fertility is medium, and the organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The shrink-swell potential is moderate.

Most areas of this soil are used for hay and pasture. The soil is too steep for continuous cropping.

This soil is suited to hay and pasture. Grasses and legumes grown for pasture and hay effectively control erosion. In establishing or reseeding grasses and legumes, minimum tillage helps to prevent excessive soil loss. Seed should be planted early enough for good ground cover to be established before the end of the growing season. A nurse crop can be planted to provide cover in late fall and winter until grasses and legumes are established. Adequate stands of grasses and legumes control runoff. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Small gullies in a few areas need to be reshaped and reseeded to grasses. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for use as building sites. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced to prevent damage by the shrinking and swelling of the soil. Dwellings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Sewage generally can be piped to adjacent areas where the soils are better suited to sewage lagoons.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage caused by shrinking and swelling, frost action, and low strength of the soil. The slope can be modified by cutting and filling, or roads and streets can be run along the slope.

The land capability classification is IVe.

17D2—Shelby clay loam, 9 to 14 percent slopes, eroded. This soil is on side slopes adjacent to narrow convex ridgetops. It is strongly sloping and moderately well drained. The individual areas are irregular in shape and range from 10 acres to over 100 acres in size.

Typically, the surface layer is very dark brown and very dark grayish brown, friable clay loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part of the subsoil is brown and dark yellowish brown, firm clay loam; the middle part is yellowish brown, firm clay loam; and the lower part is yellowish brown, mottled, firm clay loam. The substratum is yellowish brown, mottled, calcareous, firm clay loam to a depth of 60 inches or more. In some areas, the soil is so eroded that most of the present surface layer is subsoil material. In some areas the combined thickness of the surface layer and subsoil and the depth to calcareous clay loam are less than 30 inches.

Included with this soil in mapping are a few small areas of somewhat poorly drained Lamoni soils. These soils generally are higher on the side slopes and make up about 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is medium. The available water capacity is high. Natural fertility is medium, and the organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. The shrink-swell potential is moderate.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suitable for row crops and small grains if they are rotated with close-growing pasture or hay crops. Erosion remains a hazard if the soil is used continuously for cultivated crops. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are suited to terracing and contour farming. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Grasses and legumes grown for pasture and hay effectively control erosion. In establishing or reseeding grasses and legumes, minimum tillage helps to prevent excessive soil loss. Seed should be planted early enough for good ground cover to be established before the end of the growing season. A nurse crop can be planted to provide cover in late fall and winter until grasses and legumes are established. Adequate stands of grasses and legumes control runoff. Overgrazing reduces production of grasses and legumes and increases weed growth.

Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is too wet causes surface compaction, poor tilth, and excessive runoff. In a few areas, gullies need to be reshaped and reseeded to grasses. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for use as building sites and for onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Dwellings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage caused by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IVe.

17E2—Shelby clay loam, 14 to 20 percent slopes, eroded. This soil is on the lower part of side slopes adjacent to narrow convex ridgetops. It is moderately steep and moderately well drained. The individual areas are irregular in shape and range from 5 to 80 acres in size.

Typically, the surface layer is black and very dark gray, friable clay loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part of the subsoil is brown and dark yellowish brown, firm clay loam; and the lower part is dark yellowish brown, mottled, firm clay loam. The substratum is dark yellowish brown, mottled, calcareous, firm clay loam to a depth of 60 inches or more. In some areas, the soil is so eroded that most of the present surface layer is subsoil material. Also, in some areas the combined thickness of the surface layer and subsoil and the depth to calcareous clay loam are less than 30 inches.

Permeability is moderately slow, and runoff is rapid. The available water capacity is high. Natural fertility is medium, and the organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The shrink-swell potential is moderate.

Most areas of this soil are used for hay and pasture. This soil is too steep for use as cropland and should be tilled only for pasture seeding.

This soil is suited to hay and pasture. Grasses and legumes grown for pasture and hay effectively control erosion. In establishing or reseeding grasses and legumes, minimum tillage helps to prevent excessive soil loss. Seed should be planted early enough for a good ground cover to be established before the end of the growing season. A nurse crop can be planted to provide cover in late fall and winter until grasses and legumes are established. Adequate stands of grasses and legumes control runoff. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Small gullies in a few areas need to be reshaped and reseeded to grasses. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suitable for building sites. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced to prevent damage by the shrinking and swelling of the soil. Dwellings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Sewage generally can be piped to adjacent areas where the soils are better suited to sewage lagoons.

This soil is suitable for local roads and streets. Adequate side ditches and culverts and a subgrade strengthened with crushed rock or other suitable base material help to prevent damage caused by shrinking and swelling, frost action, and the low strength of the soil. The slope can be modified by cutting and filling, or roads and streets can be run along the slope.

The land capability classification is VIe.

19C—Ladoga silt loam, 5 to 9 percent slopes. This soil is on narrow ridgetops, high terraces, and side slopes of ridges. It is moderately sloping and moderately well drained. The individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 2 inches thick. The subsoil is about 38 inches thick. The upper part of the subsoil is brown, firm silty clay loam; the middle part is dark yellowish brown, mottled, firm silty clay loam; and the lower part is yellowish brown, mottled, firm silty clay loam. The substratum is yellowish brown, mottled, firm silty clay loam to a depth of 60 inches or more. In some eroded areas, the dark surface and subsurface layers are thinner. In a few areas the soil is redder throughout. In some areas slope is less than 5 percent. In some areas the soil has more clay in the subsoil and has mottles or a grayer color at a shallower depth.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a fairly wide range of moisture content. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are used for row crops, hay, and pasture. Some areas are used as woodland.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too small or narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

This soil is suited to trees. A few areas remain in native hardwoods. Seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and spraying or cutting.

This soil is suitable for building sites and for onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Small commercial buildings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Septic tank filter fields generally function properly if the length of the laterals is increased to compensate for the moderately slow permeability. Properly designed sewage lagoons function well if the area is leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IIIe.

20C2—Ladoga silty clay loam, 5 to 9 percent slopes, eroded. This soil is on side slopes of narrow ridges, on the ends of ridges, and on high terraces. It is moderately sloping and moderately well drained. The individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The subsoil is about 47 inches thick. The upper part of the subsoil is dark yellowish brown, firm silty clay loam; the middle part is dark yellowish brown, mottled, firm silty clay loam; and the lower part is yellowish brown, mottled, firm silty clay loam. The substratum is yellowish brown, mottled, firm silty clay loam to a depth of 60 inches or more. In some areas the soil is redder throughout. In some areas the soil has more clay in the subsoil and has mottles or a grayer color at a shallower depth.

Included with this soil in mapping are some areas where the soil is severely eroded and the present surface layer is mostly subsoil material. These areas make up about 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is high, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are used for row crops, hay, and pasture. Some areas are used as woodland.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of further erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too small to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

This soil is suited to trees. A few areas remain in native hardwoods. Seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and spraying or cutting.

This soil is suitable for building sites and for onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Small commercial buildings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Septic tank filter fields generally function properly if the length of the laterals is increased to compensate for the moderately slow permeability. Properly designed lagoons work well if the area is leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IIIe.

21D—Gara loam, 9 to 14 percent slopes. This soil is on side slopes adjacent to the larger streams and their tributaries. It is strongly sloping and moderately well drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark gray, friable loam about 6 inches thick. The subsurface layer is dark grayish brown, friable loam about 4 inches thick. The subsoil is about 34 inches thick. The upper part of the subsoil is dark yellowish brown, firm clay loam; the middle part is yellowish brown, firm clay loam; and the lower part is yellowish brown, mottled, firm clay loam. The substratum is strong brown, mottled, firm clay loam to a depth of 60 inches or more. In some areas, the depth to calcareous clay loam is less than 36 inches.

Included with this soil in mapping are a few small areas of somewhat poorly drained Armstrong soils. These soils generally are higher on the side slopes and make up about 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The shrink-swell potential of the subsoil is moderate.

Many areas of this soil are used as woodland. Some areas are used for hay and pasture and a few are used for row crops and small grains.

This soil is suited to trees. A few small areas remain in native hardwoods. There are no significant hazards or limitations to planting or harvesting trees.

This soil is suited to hay and pasture. Grasses and legumes effectively control erosion. Minimum tillage helps to prevent excessive soil loss in establishing or reseeding grasses and legumes. Seed should be planted early enough for a good ground cover to be established before the end of the growing season. A nurse crop can be planted to provide cover in late fall and winter until grasses and legumes are established. Adequate stands of grasses and legumes control runoff. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

Row crops and small grains are suitable on a limited basis if rotated with close-growing pasture or hay crops. There is a hazard of severe erosion if the soil is cultivated continuously. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Dwellings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Sanitary facilities can be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IVe.

21E—Gara loam, 14 to 20 percent slopes. This soil is on side slopes adjacent to stream channels and flood plains. It is moderately steep and moderately well drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark grayish brown, very friable loam about 7 inches thick. The subsurface layer is grayish brown, very friable loam about 3 inches thick. The subsoil is about 31 inches thick. The upper part of the subsoil is brown and dark yellowish brown, firm clay loam; the middle part is dark yellowish brown, mottled, firm clay loam; and the lower part of the subsoil is yellowish brown, mottled, firm clay loam. The substratum is yellowish brown, mottled, firm clay loam to a depth of 60 inches or more. In some areas, the slope is steep or very steep. In some areas, the depth to calcareous clay loam is less than 36 inches.

Included with this soil in mapping are a few small areas of Vanmeter soils. These moderately deep soils are on moderately steep to very steep convex side slopes and in areas having short, steep slopes that parallel stream channels and flood plains. These soils make up about 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is rapid. Available water capacity is high. Natural fertility is low, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The shrink-swell potential of the subsoil is moderate.

Many areas of this soil are used for woodland. Some areas are used for hay and pasture. This soil is too steep for crops and should be tilled only for pasture seeding.

This soil is suited to trees. Erosion control and equipment limitations are concerns. Roads and skid trails should be designed and constructed on the contour to minimize steepness and length of slope and concentration of water. Some of the steeper areas may require yarding logs uphill to logging roads and skid trails. Disturbed areas may need to be seeded after harvesting. Protection from fire and grazing insures adequate ground cover for erosion control and regeneration.

This soil is suited to hay and pasture. Grasses and legumes control erosion very effectively. In establishing or reseeding grasses and legumes, minimum tillage helps to prevent excessive soil loss. Seed should be planted early enough for a good ground cover to be established before the end of the growing season. A nurse crop can be planted to provide cover in late fall and winter until grasses and legumes are established. Adequate stands of grasses and legumes control runoff. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

This soil is suitable for building sites. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Dwellings can be designed to conform to the natural slope; however, land shaping is necessary in some areas. Sewage generally can be piped to sewage lagoons.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil. The slope can be modified by cutting and filling, or roads and streets can be run along the slope.

The land capability classification is VIe.

22D2—Gara clay loam, 9 to 14 percent slopes, eroded. This soil is on side slopes adjacent to stream channels and flood plains. It is strongly sloping and moderately well drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 7 inches thick. The subsoil is about 33 inches thick. The upper part of the subsoil is brown and dark yellowish brown, firm clay loam; and the lower part is dark yellowish brown, mottled, firm clay loam. The substratum is yellowish brown, mottled, calcareous, firm clay loam to a depth of 60 inches or more. In some areas, the depth to calcareous clay loam is less than 36 inches.

Included with this soil in mapping are a few small areas of somewhat poorly drained Armstrong soils. These soils are higher on the side slopes and make up about 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is low. The reaction of the surface layer varies widely as a result of local liming practices. The shrink-swell potential of the subsoil is moderate.

Many areas of this soil are used for woodland. Some areas are used for hay and pasture and a few for row crops and small grains.

This soil is suited to trees. A few small areas remain in native hardwoods. There are no significant hazards or limitations to planting or harvesting trees.

This soil is suited to hay and pasture. Grasses and legumes effectively control erosion. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

Row crops and small grains are suitable on a limited basis if rotated with close-growing pasture or hay crops. There is a hazard of further erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suitable for building sites. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of this soil. Dwellings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Sanitary facilities can be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IVe.

22E2—Gara clay loam, 14 to 20 percent slopes, eroded. This soil is on side slopes adjacent to stream channels and flood plains. It is moderately steep and moderately well drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The subsoil is about 34 inches thick. The upper part of the subsoil is dark yellowish brown, firm clay loam; and the lower part is dark yellowish brown, mottled, firm clay loam. The substratum is yellowish brown, mottled, firm clay loam to a depth of 60 inches or more. In some areas, the slope is steep or very steep. In some areas, the depth to calcareous clay loam is less than 36 inches.

Included with this soil in mapping are a few small areas of Vanmeter soils. These moderately deep soils are on moderately steep to very steep, convex side slopes and in areas having short, steep slopes that parallel stream channels and flood plains. These soils make up less than 5 percent of the unit.

Permeability is moderately slow, and surface runoff is rapid. Available water capacity is high. Natural fertility is low, and organic matter content is low. The reaction of the surface layer varies widely as a result of local liming practices. The shrink-swell potential of the subsoil is moderate.

Many areas of this soil are used for woodland, and some areas are used for hay and pasture. This soil is too steep for crops and should be tilled only for pasture seeding.

This soil is suited to trees. A few areas remain in native hardwoods. Erosion control and equipment limitations are concerns. Roads and skid trails should be designed and constructed on the contour to minimize steepness and length of slope and concentration of water. Some of the steeper areas may require yarding logs uphill to logging roads and skid trails. Disturbed areas may need to be seeded after harvesting. Protection from fire and grazing insures adequate ground cover for erosion control and regeneration.

This soil is suited to hay and pasture. Grasses and legumes control erosion very effectively. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

This soil is suitable for building sites. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Dwellings can be designed to conform to the natural slope; however, land shaping may be necessary in some areas. Sewage generally can be piped to adjacent areas where the soils are better suited to sewage lagoons.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil. The slope can be modified by cutting and filling, or roads and streets can be run along the slope.

The land capability classification is VIe.

23C—Armstrong loam, 5 to 9 percent slopes. This soil is on ridges and side slopes near rivers, large streams, and their tributaries. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable loam about 6 inches thick. The subsurface layer is brown, friable loam about 5 inches thick. The mottled subsoil extends to a depth of 60 inches or more. It is dark yellowish brown, firm clay loam in the upper part; brown and strong brown, firm clay in the middle part; and strong brown and yellowish brown, firm clay loam in the lower part. In some eroded areas, the surface layer is thinner or includes subsoil material that has been mixed in by cultivation. In some areas, the upper part of the subsoil does not contain pebbles.

Included with this soil in mapping are a few small areas of moderately well drained Gara soils. These soils generally are lower on the steeper side slopes and make up about 5 percent of the map unit.

Permeability is slow, and surface runoff is medium. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture. Some areas are used for woodland.

This soil is suited to corn, soybeans, small grains, and grasses and legumes in rotation. There is a hazard of erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay control erosion very effectively. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. A few small areas remain in native hardwoods. Planting larger seedlings than usual improves survival rates. Frequent light thinnings that reduce stand density minimize windthrow.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of this soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IIIe.

24C2—Armstrong clay loam, 5 to 9 percent slopes, eroded. This soil is on side slopes near rivers, large streams, and their tributaries. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable clay loam about 6 inches thick. The mottled subsoil is about 36 inches thick. The upper part of the subsoil is brown, firm clay loam and clay; and the lower part is yellowish brown, firm clay and clay loam. The substratum is yellowish brown, mottled, firm clay loam to a depth of 60 inches or more. In some areas there are no pebbles in the upper part of the subsoil.

Included with this soil in mapping are some areas where the soil is severely eroded and the present surface layer is mostly subsoil material. Also included are a few small areas of moderately well drained Gara soils. The Gara soils are lower on the steeper side slopes. Included areas make up about 10 percent of this map unit.

Permeability is slow, and surface runoff is rapid. Available water capacity is moderate. Natural fertility and organic matter content are low. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet, and tillage is difficult except under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture. Some areas are used for woodland.

Row crops and small grains are suitable on a limited basis if rotated with close-growing pasture or hay crops. There is a hazard of further erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Grasses and legumes control erosion very effectively. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. A few small areas remain in native hardwoods. Planting large seedlings improves the survival rate. Frequent light thinnings that reduce stand density minimize windthrow.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities can be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IIIe.

25B—Pershing silt loam, 2 to 5 percent slopes. This soil is on narrow ridgetops, high terraces, and upper side slopes of ridges. It is gently sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 6 inches thick. The mottled subsoil extends to a depth of 60 inches or more. It is brown, firm silty clay in the upper part and grayish brown, firm silty clay loam in the lower part. In some eroded areas, the surface layer is thinner or includes subsoil material that has been mixed in by cultivation. In some areas the subsoil contains less clay, and grayish brown mottles and gray colors are lower in the profile.

Permeability is slow, and surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is tilled easily throughout a moderate range in moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 2 to 4 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture. A few areas are used for woodland.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some areas are smoothly sloping and large enough to be terraced and farmed on the contour. Other areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. A few small areas remain in native hardwoods. Planting larger seedlings than usual improves survival rates. Frequent light thinnings that reduce stand density minimize windthrow.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities should be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IIIe.

26C2—Pershing silty clay loam, 5 to 9 percent slopes, eroded. This soil is on side slopes. It is moderately sloping and somewhat poorly drained. The individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 6 inches thick. The mottled subsoil extends to a depth of 60 inches or more. It is brown, firm silty clay loam in the upper part; grayish brown, firm silty clay and silty clay loam in the middle part; and dark yellowish brown, firm silty clay loam in the lower part. In some areas, the soil has been eroded to the extent that most of the present surface layer is subsoil material. In some areas the subsoil contains less clay, and grayish brown mottles and gray colors are lower in the profile.

Permeability is slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is low. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 2 to 4 feet during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture. A few areas are used for woodland.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of further erosion if this soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Most areas are smoothly sloping and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

Grasses and legumes grown for pasture and hay effectively control erosion. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing.

Grazing when the soil is wet causes surface compaction, poor tilth, and excessive runoff. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. A few small areas remain in native hardwoods. Planting larger seedlings than usual improves survival rates. Frequent light thinnings that reduce stand density minimize windthrow.

This soil is suitable for building sites and for some onsite waste disposal systems. Basement walls, foundations, and footings for dwellings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Drainage tile around footings helps to prevent damage caused by excessive wetness. Sanitary facilities can be connected to properly designed sewage lagoons. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, the low strength of the soil, and frost action.

The land capability classification is IIIe.

33E—Vanmeter flaggy silty clay loam, 14 to 40 percent slopes. This soil is on side slopes adjacent to the larger streams, rivers, and their tributaries. It is moderately deep, moderately steep to very steep, and moderately well drained. The individual areas typically are long and narrow and range from 5 acres to over 500 acres in size.

Typically, the surface layer is very dark gray and dark grayish brown, friable flaggy silty clay loam about 6 inches thick. The subsoil is about 22 inches thick. The upper part of the subsoil is brown and olive brown, firm silty clay; and the lower part is grayish brown, firm silty clay. Below the subsoil is grayish brown soft clay shale to a depth of 60 inches or more. In some areas, the upper part of the subsoil is slightly acid or medium acid. In other areas, the soil is less than 20 inches thick or more than 36 inches thick.

Included with this soil in mapping are a few small areas of Armstrong, Gara, and Ladoga soils. These deep soils are on side slopes above this Vanmeter soil. Also included are a few small rocky areas and some bedrock outcrops. These inclusions make up about 15 percent of the map unit.

Permeability is very slow, and surface runoff is rapid. Available water capacity is moderate. Natural fertility and organic matter content are low. The upper 18 inches of the soil is 5 to more than 15 percent limestone flagstones. The shrink-swell potential of the subsoil is high.

Most areas of this soil are in trees or wooded pasture. A few areas are used for pasture.

This soil is suited to trees. The main problems in planting and harvesting trees are the erosion hazard in disturbed areas, the difficulty in using equipment because of steep slope, rock outcrops, seedling mortality, and windthrow. Roads and skid trails should be designed and constructed on the contour to minimize steepness and length of slope and concentration of water. Disturbed areas may need to be seeded after harvesting. Planting larger seedlings than usual improves survival rates. Frequent light thinnings that reduce stand density minimize windthrow.

This soil is suited to pasture. Grasses and legumes control erosion very effectively. Operating machinery can be dangerous because of bedrock outcrops and flagstones on the surface and in the upper part of the soil. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing by livestock. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

This soil generally is unsuitable for building sites or for onsite waste disposal because of slope, depth to rock, and shrink-swell limitations. Soils that are better suited to these uses generally are nearby.

The land capability classification is VIIe.

44—Bremer silty clay loam. This soil is on low stream terraces that are subject to rare flooding. This soil is nearly level and poorly drained. The individual areas are irregular in shape and range from 5 acres to over 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black, friable silty clay loam about 8 inches thick. The subsoil is firm silty clay loam about 37 inches thick. The upper part of the subsoil is very dark gray, the middle part is dark grayish brown, and the lower part is dark gray. The substratum is dark gray, firm silty clay loam to a depth of 60 inches or more.

Permeability is moderately slow, and surface runoff is slow. Available water capacity, natural fertility, and organic matter content are high. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 to 2 feet during extended wet periods.

Most areas of this soil are used for row crops. A few areas are used for hay and pasture.

This soil is suited to corn, soybeans, grain sorghum, and small grains. Wetness and the rare flooding are the main problems. The wetness is caused by poor surface drainage or runoff from uplands. Poor surface drainage can be improved by land grading and properly installed surface ditches. Diversions control upland runoff. Levees or floodwater-retarding structures reduce flood damage and crop loss. Returning crop residue to the soil or regularly adding organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Rare flooding and wetness are problems. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Levees or floodwater-retarding structures reduce flood damage. Land grading and shallow surface ditches help in removing excess surface water. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. Wetness is the main problem. Equipment should be used only when the soil is dry or frozen. Ridging the soil and planting on the ridges increases seedling survival, as does planting larger seedlings than usual. Frequent light thinnings that reduce stand density minimize windthrow. Plant competition can be reduced by thorough site preparation, including prescribed burning, spraying, or cutting.

This soil generally is unsuitable for building sites or for most sanitary facilities because of the flooding. Soils that are better suited to these uses usually are nearby.

The land capability classification is IIw.

45—Humeston silt loam. This soil is on low stream terraces that are subject to rare flooding. This soil is nearly level and poorly drained. The individual areas are typically long and narrow and range from 5 to 50 acres in size.

Typically, the surface layer is black, friable silt loam about 7 inches thick. The next 15 inches is black and dark gray, friable silt loam. The subsoil extends to a depth of 60 inches or more. The upper part of the subsoil is very dark gray, firm silty clay loam; the middle part is very dark gray, very firm silty clay; and the lower part is dark gray, mottled, firm silty clay loam.

Permeability is very slow, and surface runoff is slow. Available water capacity and natural fertility are high. Organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is high. A seasonal high water table is commonly at a depth of 1 foot or less during extended wet periods.

Most areas of this soil are used for hay and pasture. Some areas are used for row crops.

This soil is suited to hay and pasture. Rare flooding and the wetness are problems. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Levees or floodwater-retarding structures reduce flood damage. Land grading and shallow surface ditches help in removing excess surface water. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to corn, soybeans, grain sorghum, and small grains. Wetness and the rare flooding are the main problems. The wetness is caused by poor surface drainage or runoff from uplands. Poor surface drainage can be improved by land grading or properly installed surface ditches. Diversions help to control upland runoff. Levees or floodwater-retarding structures reduce flood damage and crop loss. Returning crop residue to the soil or regularly adding organic material improves fertility, reduces crusting, and increases water infiltration.

This soil generally is not suitable for building sites or for most sanitary facilities because of flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIIw.

46—Arbela silt loam. This soil is on low stream terraces that are subject to occasional flooding. This soil is nearly level and poorly drained. The individual areas typically are long and narrow and range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 6 inches thick. The next 15 inches is very dark gray and dark grayish brown, friable silt loam. The subsoil extends to a depth of 60 inches or more. The upper part of the subsoil is dark grayish brown, mottled, firm silty clay loam; and the lower part is grayish brown, mottled, firm silty clay loam.

Permeability is moderately slow, and surface runoff is slow. Available water capacity and natural fertility are high. Organic matter content is moderate. The reaction of the surface layer varies as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential of the subsoil is moderate. A seasonal high water table is commonly at a depth of 1 to 2 feet during extended wet periods.

Some areas of this soil are used for row crops. Some areas are used for hay and pasture.

This soil is suited to corn, soybeans, grain sorghum, and small grains. Wetness and the occasional flooding are the main problems. The wetness is caused by poor surface drainage or runoff from uplands. Poor surface drainage can be improved by land grading or properly installed surface ditches. Diversions control upland runoff. Levees or floodwater-retarding structures reduce flood damage and crop loss. Returning crop residue to the soil or regularly adding organic material improves fertility, reduces crusting, and increases water infiltration.

Some areas of this soil are used for row crops. Some areas are used for hay and pasture.

This soil is suited to corn, soybeans, grain sorghum, and small grains. Wetness and the occasional flooding are the main problems. The wetness is caused by poor surface drainage or runoff from uplands. Poor surface drainage can be improved by land grading or properly installed surface ditches. Diversions control upland runoff. Levees or floodwater-retarding structures reduce flood damage and crop loss. Returning crop residue to the soil or regularly adding organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Occasional flooding and the wetness are problems. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. The same measures used for flood control and drainage in cultivated areas are effective in pasture. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil generally is unsuitable for building sites or for most sanitary facilities because of the flooding. Soils that are better suited to these uses usually are nearby.

The land capability classification is IIw.

51—Kennebec silt loam. This soil is on flood plains of medium and large streams and rivers. This soil is subject to occasional flooding. It is nearly level and moderately well drained. The individual areas typically are long and narrow and range from 20 acres to over 500 acres in size. Most areas cover several hundred acres.

Typically, the surface layer is black, friable silt loam about 8 inches thick. The subsurface layer is black, friable silt loam about 30 inches thick. The next layer is very dark brown, friable silt loam about 11 inches thick. The substratum, which extends to a depth of 60 inches or more, is very dark brown, friable silt loam that has a few mottles in the lower part.

Included with this soil in mapping are steeper stream banks and channels. These areas make up about 5 percent of the map unit. Also included are a few small areas of poorly drained Colo soils. These soils generally are farther from the original channel and make up about 5 percent of the map unit.

Permeability is moderate, and surface runoff is slow. Available water capacity is very high. Natural fertility and organic matter content are high. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a wide range of moisture content. The shrink-swell potential of the soil is moderate. A seasonal high water table is commonly at a depth of 3 to 5 feet during extended wet periods.

Most areas of this soil are used for row crops.

This soil is suited to corn, soybeans, grain sorghum, and small grains. This soil has no significant limitations for agricultural production if it is protected from flooding. Levees or floodwater-retarding structures reduce flood damage or crop loss. The uneven surface in a few areas may be difficult to drain. Such areas require land grading or properly installed surface ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to trees. Seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and spraying or cutting.

This soil generally is unsuitable for building sites or for most sanitary facilities because of the flooding. Soils that are better suited to these uses usually are nearby.

The land capability classification is IIw.

52B—Olmitz loam, 2 to 5 percent slopes. This soil is on foot slopes. It is gently sloping and moderately well drained. The individual areas typically are long and narrow and range from 5 acres to over 100 acres in size.

Typically, the surface layer is black, friable loam about 7 inches thick. The subsurface layer is black and very dark grayish brown, friable clay loam about 22 inches thick. The subsoil is dark brown, friable clay loam about 20 inches thick. The substratum is brown, friable clay loam to a depth of 60 inches or more.

Permeability is moderate, and surface runoff is medium. Available water capacity and natural fertility are high. Organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a fairly wide range of moisture content. The shrink-swell potential is moderate.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, grain sorghum, small grains, and grasses and legumes in rotation. There is a hazard of erosion if the soil is cultivated. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Most areas are too narrow to be managed separately, but they can be managed with adjacent soils. Returning crop residue to the soil or regularly adding organic material improves fertility, reduces crusting, and increases water infiltration. In some places, this soil is subject to erosion by runoff from adjacent uplands; diversion terraces would help to protect these areas.

Grasses and legumes grown for pasture and hay effectively control erosion. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and soil in good condition.

This soil is suitable for building sites and for onsite waste disposal systems. Basement walls, foundations, and footings for dwellings and small commercial buildings should be adequately reinforced and backfilled with sand or gravel to prevent damage by the shrinking and swelling of the soil. Septic tank absorption fields function well if the length of the laterals is increased to compensate for the moderate permeability. Properly designed sewage lagoons function well if slowly permeable material is used to seal the bottom and sides of the lagoon. Sites for lagoons need to be leveled.

This soil is suitable for local roads and streets. Providing adequate side ditches and culverts and strengthening the subgrade with crushed rock or other suitable base material help to prevent damage by shrinking and swelling, frost action, and the low strength of the soil.

The land capability classification is IIe.

54—Zook silty clay loam. This soil is on flood plains of rivers and large and small streams. This soil is subject to occasional flooding. It is nearly level and poorly drained. The individual areas are irregular in shape and range from 5 acres to over 400 acres in size.

Typically, the surface layer is black, friable silty clay loam about 6 inches thick. The subsurface layer is black, friable and firm silty clay loam and silty clay about 24 inches thick. The subsoil is very dark gray, firm silty clay about 20 inches thick. The substratum is dark gray, mottled, firm silty clay to a depth of 60 inches or more. In some depressional areas, the soil is finer textured throughout. In some other places, the subsoil is silty clay loam.

Included with this soil in mapping are a few areas of moderately well drained Nodaway soils. Nodaway soils are adjacent to the channel and are silt loam throughout. They make up less than 5 percent of this map unit.

Permeability is slow, and surface runoff is very slow. Available water capacity is moderate. Natural fertility and organic matter content are high. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is sticky when wet and is easily tilled only under optimum moisture conditions. This soil becomes cloddy and difficult to manage if worked when wet. The shrink-swell potential is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops. Some areas are used for hay and pasture.

This soil is suited to corn, soybeans, grain sorghum, and small grains. Wetness and the occasional flooding are the main problems. The wetness is caused by poor surface drainage, which can be improved by land grading or properly installed surface ditches. Levees or floodwater-retarding structures reduce flood damage and crop loss. Deep tillage in fall improves tilth and internal drainage and allows earlier planting in spring. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Occasional flooding and the wetness are problems. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Levees or floodwater-retarding structures reduce flood damage. Land grading or shallow surface ditches help in removing excess surface water. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil generally is unsuitable for building sites or for most sanitary facilities because of the flooding. Soils that are better suited to these uses usually are nearby.

The land capability classification is IIw.

55—Colo silty clay loam. This soil is on low terraces, alluvial fans, wide drainageways, and bottom lands along rivers and large streams. This soil is subject to occasional flooding. It is nearly level and poorly drained. The individual areas are irregular in shape and range from 5 acres to more than 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 8 inches thick. The subsurface layer is black, friable silty clay loam about 29 inches thick. The next layer is very dark gray, firm silty clay loam about 10 inches thick. The substratum is very dark gray, mottled, firm silty clay loam to a depth of 60 inches or more. In some areas the subsoil contains more clay.

Included with this soil in mapping are a few small areas of moderately well drained Nodaway soils. These soils generally are closer to the streams or rivers and make up about 5 percent of the map unit.

Permeability is moderate, and surface runoff is slow. Available water capacity, natural fertility, and organic matter content are high. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for row crops. Some areas are used for hay and pasture.

This soil is suited to corn, soybeans, grain sorghum, and small grains. Wetness and the occasional flooding are the main problems. The wetness is caused by poor surface drainage or runoff from uplands. Poor surface drainage can be improved by land grading or properly installed surface ditches. Diversions intercept runoff from adjacent uplands. Levees or floodwater-retarding structures reduce flood damage and crop loss. Deep tillage in fall improves tilth and internal drainage and allows earlier planting in spring. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Occasional flooding and the wetness are problems. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Levees or floodwater-retarding structures reduce flood damage. Land grading or shallow surface ditches help in removing excess surface water. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil generally is unsuitable for building sites or for most sanitary facilities because of the flooding. Soils that are better suited to these uses usually are nearby.

The land capability classification is IIw.

56—Nevin silt loam. This soil is on low stream terraces that are subject to rare flooding. This soil is nearly level and somewhat poorly drained. The individual areas are irregular in shape and range from 5 acres to several hundred acres in size.

Typically, the surface layer is black, friable silt loam about 8 inches thick. The subsurface layer is black and very dark gray, friable silty clay loam about 16 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, firm silty clay loam about 26 inches thick. The substratum is grayish brown, mottled, firm silty clay loam to a depth of 60 inches or more.

Permeability is moderate, and runoff is slow. Available water capacity, natural fertility, and organic matter content are high. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a wide range of moisture content. The shrink-swell potential of the subsoil is moderate. A seasonal high water table is commonly at a depth of 2 to 4 feet during extended wet periods.

Most areas of this soil are used for row crops.

This soil is suited to corn, soybeans, grain sorghum, and small grains. This soil has no significant limitations for agricultural production if it is protected from flooding and from runoff from adjacent uplands. Levees or floodwater-retarding structures reduce flood damage and crop loss. Diversions control runoff from uplands. A few areas have an uneven surface that may be difficult to drain. Such areas require land grading or properly installed surface ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil generally is unsuitable for building sites or for most sanitary facilities because of flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is I.

57A—Colo silty clay loam, channeled, 0 to 3 percent slopes. This soil is on narrow drainageways that dissect and branch into the sloping uplands. This soil is subject to frequent flooding. It is nearly level and gently sloping and is poorly drained. The individual areas are long and narrow and range from 5 acres to several hundred acres in size.

Typically, the surface layer is black, friable silty clay loam about 12 inches thick. The subsurface layer is black, friable and firm silty clay loam about 25 inches thick. The next layer is very dark gray, firm silty clay loam about 17 inches thick. The substratum is dark gray, mottled, firm silty clay loam to a depth of 60 inches or more. In some areas the soil contains more clay throughout.

Included with this soil in mapping are steeper stream banks and channels. Also included are some accessible areas where the channels have been straightened. The included areas make up about 10 percent of the map unit.

Permeability is moderate, and surface runoff is slow. Available water capacity, natural fertility, and organic matter content are high. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a moderate range of moisture content. The shrink-swell potential is high. A seasonal high water table is commonly at a depth of 1 to 3 feet during extended wet periods.

Most areas of this soil are used for hay and pasture. Some areas are used for woodland. A few accessible areas are farmed to row crops with adjoining areas.

This soil is suited to hay and pasture. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well on this soil because of the high water table. Inaccessibility is a problem in most areas when harvesting forage crops. Ditchbank erosion, wetness caused by poor surface drainage or runoff from adjacent uplands, and frequent flooding are the main problems. Reshaping the surface and seeding ditchbanks or building small grade-stabilization structures help to control ditchbank erosion. Poor surface drainage can be improved by land grading or properly installed surface ditches. Diversions help to control runoff from higher areas. Levees or floodwater-retarding structures reduce flood damage and crop loss.

Overgrazing pasture reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. Many areas which cannot be farmed could profitably support a stand of hardwoods or conifers. This soil is also suitable for development of openland, woodland, and wetland habitat for wildlife. Wetness-tolerant plants are preferable for food and cover.

This soil generally is unsuitable for cultivated crops because most areas are too narrow and channeled for use of large machinery. Many areas are highly dissected by gullies that stem from upland drainageways and the meanders of intermittent streams.

This soil generally is unsuitable for building sites or for most sanitary facilities because of the flooding. Soils that are better suited to these uses usually are nearby.

The land capability classification is Vw.

58—Wabash silty clay. This soil is on flood plains of rivers and large streams and is subject to occasional flooding. It is nearly level to depressional and is very poorly drained. The individual areas are irregular in shape and range from 10 acres to over 100 acres in size.

Typically, the surface layer is black, firm silty clay about 9 inches thick. The subsurface layer is black, firm silty clay about 9 inches thick. The subsoil is black and very dark gray, very firm silty clay to a depth of 60 inches or more. In some areas the soil contains less clay.

Permeability and surface runoff are very slow. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is very sticky when wet and hard when dry. Tillage is somewhat difficult even under optimum moisture conditions, and the soil becomes cloddy and difficult to manage if worked when wet. The shrink-swell potential is very high. A seasonal high water table is within 1 foot of the surface during extended wet periods.

Most areas of this soil are used for row crops, hay, and pasture.

This soil is suited to corn, soybeans, and grain sorghum. Wetness and the occasional flooding are the main problems. The wetness is caused by the very poor surface drainage. Levees or floodwater-retarding structures reduce flood damage and crop loss. Poor surface drainage can be improved by land grading or properly installed surface ditches. Deep tillage in fall improves tilth and internal drainage and allows earlier planting in spring. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to hay and pasture. Occasional flooding and the wetness are problems. Pasture and hay plants that tolerate wetness do well on this soil. Deep-rooted legumes, such as alfalfa, do not grow well because of the high water table. Levees or floodwater-retarding structures reduce flood damage. Land grading or shallow surface ditches help in removing excess surface water. Overgrazing reduces production of grasses and legumes and increases weed growth. Timely mowing reduces competition from undesirable plants and encourages uniform grazing. Grazing when the soil is wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees. Wetness is the main problem. Equipment should be used only when the soil is dry or frozen. Ridging the soil and planting seedlings on the ridges increase survival, as does planting large seedlings. Frequent light thinnings that reduce stand density minimize windthrow. Plant competition can be reduced by thorough site preparation, including prescribed burning, spraying, or cutting.

This soil generally is unsuitable for building sites or for most sanitary facilities because of flooding. Soils that are better suited to these uses generally are nearby.

The land capability classification is IIIw.

66—Nodaway silt loam. This soil is on flood plains of medium and large streams and rivers. This soil is subject to occasional flooding. It is nearly level and moderately well drained. The individual areas typically are long and narrow to moderately wide and range from 20 acres to over 1,000 acres in size. Most areas cover several hundred acres.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The substratum is stratified dark grayish brown, very dark gray, very dark grayish brown, grayish brown, and brown, friable silt loam to a depth of 60 inches or more. Some areas are undulating. These undulating areas commonly are remnants of old meandering streams.

Included with this soil in mapping are low lying, half-moon-shaped areas in the meanders of old stream channels and along straightened channels. The soils in these areas have a loam to very fine sandy loam surface layer underlain by sand. These areas typically are as much as 10 to 20 feet lower than the adjoining Nodaway soils and are flooded more frequently. Small sandy spots are shown by a sand symbol on the maps. Most of these areas are along the Grand River or one of its three forks. They make up about 5 percent of the map unit. Also included with this soil in mapping are steeper streambanks and channels. These areas make up about 5 percent of the map unit.

Permeability is moderate, and surface runoff is slow. Available water capacity is very high. Natural fertility is high, and organic matter content is moderate. The reaction of the surface layer varies widely as a result of local liming practices. The surface layer is friable and is easily tilled throughout a wide range of moisture content. The shrink-swell potential is moderate.

Most areas of this soil are used for row crops.

This soil is suited to corn, soybeans, grain sorghum, and small grains. This soil has no significant limitations for agricultural production if it is protected from flooding. Levees or floodwater-retarding structures reduce flood damage or crop loss. A few areas have an uneven surface that may be difficult to drain. Such areas require land grading or properly installed surface ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

This soil is suited to trees. Seedlings survive and grow well if competing vegetation is controlled or removed by site preparation and spraying or cutting.

This soil generally is unsuitable for building sites or for most sanitary facilities because of the flooding. Soils that are better suited to these uses usually are nearby.

The land capability classification is IIw.

88—Pits, quarries. This map unit consists of open excavations from which soil material has been removed to expose the underlying sand, gravel, or limestone bedrock. Some quarries are operational, others have been abandoned. The individual areas range from 5 acres to over 100 acres in size.

A typical quarry has a vertical rock face on two or three sides. These exposures are 10 feet to more than 100 feet high and are mostly limestone with lesser amounts of shale. Above the rock is an overburden of glacial material 1 to 25 feet thick. In some places, there is 3 to 10 feet of loess over the glacial material. The overburden is removed and stockpiled on adjoining undisturbed areas or put in previously mined pits.

One area is a sand pit on the West Fork of the Grand River. The sand is taken from sandbars along the channel and processed and stockpiled on the adjoining bottom land.

Some areas have been reshaped and reseeded. The restored topsoil is a mixture of original topsoil, subsoil, and gravelly or stony material and has poor tilth and very little organic matter. Most areas are rough and steep and grow mostly weeds and brush. Some areas are used for pasture. Even with proper reclamation, however, most areas are best suited to use as wildlife habitat or recreation areas. Some abandoned deep pits have no outlet and fill with water.

No land capability classification was assigned.

Prime Farmland

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to producing food, feed, forage, fiber, and oilseed crops. The soil qualities, growing season, and moisture supply are those that produce a sustained high yield of crops economically if the soil is managed well. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment. Prime farmland is of major importance in meeting the nation's short- and long-term needs for food and fiber. Because the supply of high-quality farmland is limited, it must be used wisely. The loss of prime farmland to urban and other uses puts pressure on marginal lands, which generally are less productive.

Prime farmland must either be currently used for producing food or fiber or be available for this use. It may be in crops, pasture, timber, or other uses. Urban or built-up land and water areas cannot be considered prime farmland.

About 24 percent of Gentry County, 74,500 acres, is prime farmland. An additional 23,350 acres meets the requirements if the soils are drained. Of the prime farmland in Gentry County, approximately 29,000 acres is Grundy silt loam, 2 to 5 percent slopes, and more than 27,000 acres is Nodaway silt loam. The rest is scattered areas of other soils. Most of the prime farmland in the county is used for crops.

The soils that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed soil is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units."

If a soil meets the requirements for prime farmland only where drained, that is specified in parentheses after the soil name in table 5. Onsite investigation is needed to determine whether a specific area of the soil is adequately drained. In Gentry County, most areas of the naturally wet soils have been artificially drained.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

The potential of the soils in Gentry County for sustained production of food is good. About 32 percent (approximately 100,000 acres) of the county is prime farmland. However, only about 18 percent of the cropland and pasture in the county is adequately treated to meet conservation needs *(3)*. Inadequately treated cropland is mostly uplands being farmed in a manner that causes erosion heavy enough to eventually reduce productivity. Some of the marginal cropland used for row crops should be converted to producing pasture or hay. Soil erosion on most of the cropland can be held to a tolerable level by using a system of conservation practices (fig. 8).

Loss of cropland to highway construction and urban development has been slight. This survey can help in making land use decisions that will influence the future role of farming in the county.

Erosion is the major problem on nearly all sloping cropland and overgrazed pasture in Gentry County. All soils with slopes in excess of 2 percent are susceptible to erosion damage.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Second, soil erosion on farmland results in sediment entering streams, lakes, and ponds.

Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Grundy, Pershing, Lagonda, Lamoni, Armstrong, and Clarinda soils. Seedbed preparation and tillage are difficult on clayey soils where the original friable surface layer has been eroded away. Erosion also reduces productivity of Vanmeter soils, which tend to be droughty because of the presence of bedrock within 3 feet of the surface.

Control of erosion minimizes the pollution of streams by sediment and improves the quality of water for municipal use, for recreation, and for fish and wildlife habitat. Erosion control also prolongs the useful life of ponds and lakes by preventing them from filling with sediment.

Figure 8.—Terraces, contour stripcropping, and grassed waterways on Lamoni clay loam, 5 to 9 percent slopes, eroded.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps plant cover or residue on the soil can hold erosion losses to a minimum and maintain the productive capacity of the soil. Growing grasses and legumes for pasture and hay is effective in controlling erosion.

Terraces reduce the length of the slope and thereby reduce runoff and erosion. Conventional terraces are most practical on uneroded, gently and moderately sloping upland soils on long, smooth side slopes. Special construction and management techniques are necessary for terrace systems to be effective on most strongly sloping Gara and Shelby soils. Construction of grassed backslope terraces reduces the steepness of the slope. Construction of conventional terraces actually increases the slope and makes additional erosion control practices crucial; a cropping system that provides a substantial plant cover is needed to control erosion unless conservation tillage is practiced and large amounts of residue are used. Soil loss on moderately steep Gara and Shelby soils is severe if these soils are cultivated. Minimizing tillage on sloping soils and leaving large quantities of crop residue on the surface help to increase infiltration and reduce runoff and erosion. These practices can be used on many of the soils in the survey area but are more difficult to use successfully on eroded soils that have a clayey surface layer. On Grundy, Lagonda, Clarinda, Lamoni, and Armstrong soils, special management techniques are sometimes required where terracing exposes the clayey subsoil.

Terraces are not suited to some soils. Contour stripcropping reduces erosion by maintaining contoured strips of meadow crops in a short-term rotation. The areas between the strips are cultivated and row crops are planted on the contour. The grass or grass-legume strips usually are used for hay. No-till is effective in reducing erosion on sloping soils. It can be used on many soils in the survey area. On severely eroded soils, however, no-till management requires special techniques.

Soil wetness and flooding are problems on about 17 percent of the acreage used for crops and pasture in the survey area. All soils having slopes of less than 2 percent, except Nevin and Kennebec soils, are limited for some agricultural uses by wetness. Wabash soils are naturally so wet that crop growth usually is reduced during some part of the year. Somewhat less wet are the Colo, Zook, Bremer, and Humeston soils. Land grading or surface drainage usually is needed to some extent on all of these soils.

Occasional flooding can be a problem on the Arbela, Kennebec, Zook, Colo, Wabash, and Nodaway soils. Flooding usually occurs between November and July.

Soil fertility is naturally lower in most of the eroded soils and the moderately deep soils in the survey area than in the uneroded deep soils. However, all soils require additional plant nutrients for optimum production. Most soils in the survey area are naturally acid in the upper part of the rooting zone. They require applications of ground limestone to raise the pH sufficiently for best growth of legumes. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crop, and on the production level desired. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to apply.

Soil tilth is an important factor in germination of seeds and infiltration of water into the soil. Soils with good tilth are granular and porous. Regular additions of crop residue, manure, and other organic material help to improve soil structure and tilth. Growing legumes such as clover and alfalfa improves tilth and provides nitrogen for the following crop in the rotation.

Most of the uneroded upland soils used for crops in the survey area have a dark silt loam or silty clay loam surface layer that is medium to high in content of organic matter. Generally, the structure of the silt loam soils is weakened by tillage and compaction; consequently, intense rainfall causes the formation of a crust on the surface. The crust is hard when dry and reduces water infiltration and increases runoff.

The surface layer of eroded upland soils has higher clay content than that of uneroded soils; therefore, the eroded soils have poorer tilth, slower infiltration, and more rapid runoff. Conservation practices that control erosion on these soils prevent further deterioration of tilth.

Fall plowing is common in the survey area but is undesirable on most upland soils. Most cropland consists of sloping soils that are subject to damaging erosion if they are plowed in the fall.

Clarinda, Zook, and Wabash soils are clayey. Tilth is a problem because these soils often stay wet until late in spring. If plowed when wet, these soils tend to be cloddy when dry, so that preparing a seedbed is difficult. Plowing the Zook and Wabash soils in the fall generally results in better tilth. Clarinda soils, however, are moderately sloping: fall plowing would make them susceptible to damaging erosion. Clarinda soils require special management, and the choice of plants is limited.

The most common field crops in this county are corn and soybeans. They were grown on about 105,000 acres in 1980. Grain sorghum was grown on about 4,000 acres.

Wheat is the most common close-growing crop (14,000 acres). Oats and rye can be grown, and grass seed is produced from bluegrass, bromegrass, fescue, and orchardgrass. Double cropping is an alternative. Soybeans can be planted directly into wheat stubble. Large amounts of residue on the surface are helpful in protecting the soil from erosion. Limitations are lack of a plentiful water supply and the length of the growing season.

Suitable pasture and hay plants include several legumes, cool-season grasses, and warm-season native grasses. Alfalfa and red clover are the common legumes grown for hay. They are also used in mixtures with bromegrass, orchardgrass, fescue, or timothy for hay and pasture. Birdsfoot trefoil is used in mixtures with bromegrass, orchardgrass, fescue, and bluegrass for pasture.

Warm-season native grasses adapted to this area are big bluestem, little bluestem, indiangrass, and switchgrass. These grasses produce well during the summer. They need different management techniques for establishment and grazing than cool-season grasses.

Alfalfa is best suited to deep, moderately well drained soils such as Gara, Shelby, Sharpsburg, Ladoga, Kennebec, Olmitz, and Nodaway soils. The other legumes and all grasses do well on most of the upland soils in the survey area. The bottom-land soils that flood occasionally and stay wet for long periods, such as Zook and Wabash soils, are not suited to some grasses. They are better suited to short-season summer annuals.

The major management concern on most of the pasture is overgrazing and gully erosion. Grazing should be controlled so that the plants not only survive but give optimum production. Managing grazing to maintain plant vigor helps to control runoff and gully erosion.

Small acreages of specialty crops such as sunflowers, fruits, and vegetables are grown in the survey area. These crops require special equipment, management, and propagation techniques.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit *(9)*. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production. There are no class VIII soils in Gentry County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The land capability classification of each map unit is given in the section "Detailed Soil Map Units" and in table 6.

Woodland Management and Productivity

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

In 1972, about 8 percent of Gentry County was used for commercial timber *(10)*. Since then, the percentage may have increased slightly.

The Armstrong-Gara-Vanmeter association has most of the woodland in the county. The better quality stands consist of white oak, northern red oak, black oak, hickory, and black walnut. Many of the timber stands, however, consist of hickory, bur oak, shingle oak, hackberry, ash, basswood, and sugar maple. Ladoga, a minor soil in this association, has moderate potential for the production of trees. It is well suited to black walnut and white oak.

Timber in the Nodaway-Zook association generally grows only in areas along the major rivers and tributaries and low-lying areas that are flooded frequently or are too wet for cultivation. The main species are cottonwood, silver maple, elm, ash, hackberry, bur oak, sycamore, black willow, and boxelder. The potential for wood production is high to very high in this association. Nodaway, Kennebec, and Olmitz soils are well suited to intensive management of black walnut.

The Lamoni-Shelby and Grundy associations are prairie; most woodland is restricted to fence rows and drainageways.

Past mistreatment, such as grazing, fire, and indiscriminate harvesting, has reduced the quality of woodland in Gentry County.

Table 7 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 7, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that few trees may be blown down by strong winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service, the Missouri Department of Conservation, or the Cooperative Extension Service or from a nursery.

Recreation

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

According to the 1980 Statewide Comprehensive Outdoor Recreation Plan (SCORP), 2,101 acres in Gentry County have been developed for recreational uses *(7)*. Of this acreage, 31 percent is state land, 12 percent is municipal land, and 1 percent is part of a school. The rest is under other control.

The facilities include swimming pools and areas for other water sports, golf courses, ballfields, playgrounds, game courts, picnic areas, nature areas, trails, fairgrounds, horse arenas, areas for hunting and fishing, and areas for viewing wildlife.

There are no major public recreation areas. Only two state facilities Elam Bend Wildlife Area and Andy Denton Public Access Area, are larger than 100 acres. These areas offer upland game hunting, fish ponds, river access for boating, and primitive camping sites. Several

Figure 9.—Water impoundment on Gara loam, 14 to 20 percent slopes. Scenic quality is important in selecting a recreation site.

private and semiprivate commercial recreation enterprises are in operation. The main recreational need in Gentry County is water-sport areas.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites (fig. 9), and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have gentle slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking amd horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

Gentry County is 1 of 11 counties that make up the Northern Riverbreaks Zoogeographic Region in Missouri. Originally, this region was a mixture of prairie (70 percent) and woodland (30 percent). Today about 50 percent of the county is classified as cropland and 33 percent as grassland. The rest is woodland or is in other uses.

A significant amount of woodland has been converted to cropland and grassland over the past 20 years. Both upland and bottom land forests are still being cleared but at a slower rate than in past years. Forest revegetation in other areas is also occurring. In the northern part of the county, many grassland areas are now used for row crop production. The loss of woodland to more intensive agricultural uses is the major problem affecting the wildlife resource in Gentry County. Larger fields, and the subsequent loss of wooded travelways within the field, are also a problem.

Songbird populations are rated excellent in each of the general soil map associations in the county. The furbearer population is rated fair. Raccoon, coyote, muskrat, striped skunk, beaver, fox, badger, and mink are the most abundant. Prairie species, for example, upland sandpiper, marsh hawk, badger, and prairie chicken, are still reported from time to time even though their original grassland habitat is almost nonexistent today. Most of the sightings are reported in the southwestern part of the county.

The soils in the Armstrong-Gara-Vanmeter association are the only soils on which wooded vegetation is dominant, covering more than half of the acreage. These, and the timbered soils of the other associations, provide the habitat necessary for woodland wildlife. The deer population is rated good, and the carrying capacity of the habitat has not yet been reached. Wild turkeys were stocked in 1977. They are increasing in number and are spreading into available habitat. Squirrel numbers, primarily fox squirrel, are rated good. The woodcock population, concentrated in the Grand River basin area, is small.

Soils in the Lamoni-Shelby, the Grundy, and the Nodaway-Zook associations provide most of the habitat for openland wildlife. The quail population ranges from fair to good. The rabbit and dove populations are rated excellent. The ringnecked pheasant population is rated fair; it has not been increasing.

Wetland habitat is scarce in Gentry County. There are only a few areas on bottom lands in the Nodaway-Zook association. The waterfowl population is rated poor to fair. It increases significantly, however, during flooding of the large bottom land between the East and Middle Forks of the Grand River. Small numbers of wood ducks can be found along the Panther, Little Muddy, and Big Muddy Creeks.

There are approximately 79 miles of perennial streams in the county. The Grand River and its East, Middle, and West Forks provide the major public sport fishery. The principal stream fishes are catfish, including channel catfish, flathead, black bullhead, and carp.

Public impoundments are few in the county. Only the Limpp Community Lake and King City Reservoir offer public fishing. There are approximately 2,200 farm ponds and small lakes in the county that have been stocked with fish, mainly largemouth bass, channel catfish, and bluegill.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, millet, soybeans, and grain sorghum.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface soil, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bluegrass, switchgrass, orchardgrass, indiangrass, clover, alfalfa, trefoil, and crownvetch.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, pokeweed, foxtail, croton, and partridgepea.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, wild plum, sumac, persimmon, and sassafras. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are autumn-olive, crabapple, Amur honeysuckle, and hazelnut.

Coniferous plants furnish winter cover, browse, and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cutgrass, cattail, rushes, and sedges.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, red fox, woodchuck, and mourning dove.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, and shrink-swell potential can cause the movement of footings. A high water table, depth to bedrock, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 12 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more

Figure 10.—Ponds provide water for livestock and recreation. The soil is Lamoni clay loam, 5 to 9 percent slopes, eroded.

than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment (fig. 10). Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding;

slope; susceptibility to flooding; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as 15 percent, an appropriate modifier is added, for example, "flaggy." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly

erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(11)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudoll (*Argi*, meaning an argillic horizon present, plus *udoll*, the suborder of Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual *(8)*. Many of the technical terms used in the descriptions are defined in Soil Taxonomy *(11)*. Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Arbela Series

The Arbela series consists of deep, poorly drained, moderately slowly permeable soils on low stream terraces. The soils formed in silty alluvial sediment. Slope ranges from 0 to 2 percent.

Arbela soils are similar to Humeston soils and commonly are adjacent to Colo and Nodaway soils. Colo soils do not have an E horizon. They are on bottom lands below Arbela soils or along drainageways adjacent to Arbela soils. Humeston soils are darker in the upper part of the B horizon and generally have more clay and lower chroma in the B horizon. Nodaway soils do not have an E horizon, are lighter colored, and are on bottom lands below Arbela soils.

Typical pedon of Arbela silt loam, 550 feet north and 1,650 feet west of the southeast corner of sec. 21, T. 62 N., R. 32 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine granular; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

A—6 to 12 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak thin platy structure parting to weak fine granular; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

E—12 to 21 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak thin platy structure parting to weak fine granular; friable; common fine and very fine roots; medium acid; clear smooth boundary.

Btg1—21 to 30 inches; dark grayish brown (10YR 4/2) silty clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; moderate fine subangular blocky structure; firm; few fine and very fine roots; light brownish gray (10YR 6/2) coatings on peds in upper part of horizon; common black (10YR 2/1) stains; common distinct clay films; strongly acid; gradual smooth boundary.

Btg2—30 to 45 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; weak fine and medium subangular blocky structure; firm; few fine and very fine roots; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; few distinct clay films; strongly acid; gradual smooth boundary.

BCg—45 to 60 inches; grayish brown (10YR 5/2) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak coarse prismatic structure; firm; medium acid.

The solum typically is more than 5 feet thick, but the thickness ranges from 52 inches to more than 60 inches. The total thickness of the A and E horizons ranges from 18 to 31 inches.

The A horizon has color value of 3 and chroma of 1 or 2. The E horizon has color value of 4 or 5 and chroma of 1 or 2. The B horizon has color value of 4 or 5 and chroma of 2. There are few to common dark yellowish brown to yellowish brown mottles in the B horizon.

Armstrong Series

The Armstrong series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. The soils formed in weathered glacial till. Slope ranges from 5 to 9 percent.

Armstrong soils are similar to Pershing soils and commonly are adjacent to Gara, Ladoga, and Pershing soils. Gara soils are moderately well drained, do not have red and gray mottles in the upper part of the B horizon, and are on steeper side slopes below Armstrong soils. Ladoga soils are moderately well drained, do not have red and gray mottles in the upper part of the B horizon, do not contain glacial sand and pebbles, and are on side slopes and ridges above Armstrong soils. Pershing soils have a silty A horizon and do not have sand and glacial pebbles in the upper part of the solum.

Typical pedon of Armstrong loam, 5 to 9 percent slopes, 300 feet west and 1,100 feet south of the northeast corner of sec. 28, T. 62 N., R. 31 W.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine and medium roots; neutral; clear smooth boundary.

E—6 to 11 inches; brown (10YR 4/3) loam; weak fine granular structure; friable; many fine and medium roots; medium acid; clear smooth boundary.

Bt1—11 to 16 inches; dark yellowish brown (10YR 4/4) clay loam; common fine prominent strong brown (7.5YR 5/6) and common fine distinct grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; firm; common fine and very fine roots; pale brown (10YR 6/3) coatings on faces of peds; strongly acid; abrupt smooth boundary.

2Bt2—16 to 25 inches; brown (7.5YR 4/4) clay; many medium prominent yellowish red (5YR 4/6) and common fine prominent grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; firm; common fine and very fine roots; common distinct clay films; common fine pebbles, stone line at top of horizon; strongly acid; clear smooth boundary.

2Bt3—25 to 36 inches; strong brown (7.5YR 5/6) clay; common fine prominent grayish brown (10YR 5/2) and few fine distinct yellowish red (5YR 5/6) mottles; moderate fine subangular blocky structure; firm; common fine and very fine roots; common distinct clay films; common fine pebbles; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

2Bt4—36 to 51 inches; strong brown (7.5YR 5/6) clay loam; common fine and medium prominent gray (5Y 6/1) and light brownish gray (2.5Y 6/2) mottles; weak fine and medium subangular blocky structure; firm; few fine and very fine roots; few faint clay films; common fine and medium pebbles; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

2BC—51 to 60 inches; yellowish brown (10YR 5/6) clay loam; common fine and medium prominent light olive gray (5Y 6/2) mottles; weak fine subangular blocky structure; firm; common fine and medium pebbles; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; neutral.

The thickness of the solum and the depth to free carbonates range from 42 inches to more than 60 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The E horizon has color value of 4 or 5 and chroma of 2 or 3. In some pedons in cultivated or eroded areas, the E horizon has been incorporated into the Ap horizon and is evident only by silt coatings on peds. The B horizon has hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 to 6.

Bremer Series

The Bremer series consists of deep, poorly drained, moderately slowly permeable soils on low stream terraces. The soils formed in silty alluvial sediment. Slope ranges from 0 to 2 percent.

Bremer soils commonly are adjacent to Colo, Nevin, and Zook soils. Colo and Zook soils have a mollic epipedon 36 inches or more thick and are on bottom lands below Bremer soils. Colo soils are also along small drainageways adjacent to Bremer soils. Nevin soils have higher chroma in the B horizon and are on the more sloping parts of low stream terraces.

Typical pedon of Bremer silty clay loam, 2,540 feet west and 1,845 feet south of the northeast corner of sec. 31, T. 63 N., R. 31 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; common fine and very fine roots; neutral; abrupt smooth boundary.

A—8 to 16 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

Bt—16 to 28 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate fine prismatic structure parting to moderate fine subangular blocky; firm; common fine and very fine roots; few faint clay films; slightly acid; gradual smooth boundary.

Btg1—28 to 44 inches; dark grayish brown (10YR 4/2) silty clay loam; faces of peds dark gray (10YR 4/1); common fine faint brown (10YR 4/3) mottles; moderate fine prismatic structure; firm; few fine and very fine roots; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; common distinct clay films; slightly acid; gradual smooth boundary.

Btg2—44 to 53 inches; dark gray (10YR 4/1) silty clay loam; common fine distinct yellowish brown (10YR 5/4) mottles; moderate fine prismatic structure; firm; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; few distinct clay films; slightly acid; gradual smooth boundary.

Cg—53 to 60 inches; dark gray (10YR 4/1) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; firm; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid.

The solum ranges from 40 to 60 inches in thickness. The A horizon ranges from 14 to 24 inches in thickness.

The A horizon has hue of 10YR or N, value of 2, and chroma of 0 or 1. It dominantly is silty clay loam but the range includes silt loam. The B horizon has color value of 3 to 5 and chroma of 2 or less. It dominantly is silty clay loam but the range includes silty clay. The C horizon has hue of 10YR to 5Y and value of 4 or 5. There are few to common fine mottles of high and low chroma in the lower part of the B horizon and the C horizon.

Clarinda Series

The Clarinda series consists of deep, poorly drained, very slowly permeable soils on uplands. The soils formed in exhumed gray clayey paleosols that had formed in glacial till. Slope ranges from 5 to 9 percent.

These soils typically have a thinner dark A horizon than that defined for the Clarinda series, but this difference does not affect the usefulness or behavior of the soils.

Clarinda soils commonly are adjacent to Grundy and Lamoni soils. Grundy soils have less clay and sand than Clarinda soils; they are somewhat poorly drained and are in positions above Clarinda soils. Lamoni soils contain more sand and less clay and are in positions below Clarinda soils.

Typical pedon of Clarinda silty clay loam, 5 to 9 percent slopes, eroded, 342 feet west and 816 feet north of the southeast corner of sec. 10, T. 61 N., R. 32 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; many fine and very fine roots; medium acid; abrupt smooth boundary.

AB—6 to 9 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; firm; common very fine roots; few fine prominent yellowish brown (10YR 5/6) stains; strongly acid; abrupt smooth boundary.

2Btg1—9 to 16 inches; gray (10YR 5/1) clay; few fine distinct and prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure;

very firm; few very fine roots; few fine prominent yellowish red (5YR 4/8) stains; few fine and medium black (10YR 2/1) concretions of iron and manganese oxides; few fine distinct black (10YR 2/1) coatings; many distinct clay films; strongly acid; gradual smooth boundary.

2Btg2—16 to 28 inches; gray (10YR 5/1) clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very firm; few very fine roots; few fine sand grains and pebbles; few fine distinct black (10YR 2/1) stains and concretions of iron and manganese oxides; many distinct clay films; medium acid; gradual smooth boundary.

2Btg3—28 to 48 inches; gray (5Y 5/1) clay; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; very firm; few fine pebbles; few fine prominent black (10YR 2/1) stains and concretions of iron and manganese oxides; many distinct clay films; slightly acid; gradual smooth boundary.

2Btg4—48 to 60 inches; gray (5Y 6/1) clay; many medium prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; very firm; common fine pebbles; many fine and medium prominent yellowish red (5Y 4/8) stains; common faint clay films; neutral.

The solum ranges from 50 inches to more than 60 inches in thickness. The mollic-colored surface layer ranges from 5 to 9 inches in thickness.

The A horizon has color value of 2 or 3. The 2B horizon has hue of 10YR to 5Y and value of 4 to 6. Mottles dominantly have hue of 5YR to 10YR, value of 4 or 5, and chroma of 4 to 8. The 2B horizon is clay or silty clay. Some pedons have a few pebbles in the 2B horizon.

Colo Series

The Colo series consists of deep, poorly drained, moderately permeable soils on flood plains and in small drainageways. The soils formed in silty alluvial sediment. Slope ranges from 0 to 3 percent.

Colo soils are similar to Zook soils and commonly are adjacent to Arbela, Bremer, Humeston, Kennebec, and Zook soils. Arbela, Bremer, and Humeston soils have a mollic epipedon less than 36 inches thick; they are on second bottoms above Colo soils. Arbela and Humeston soils have an E horizon. Kennebec soils contain less clay throughout and are closer to river channels or meander belts. Zooks soils have more clay in the solum.

Typical pedon of Colo silty clay loam, 0 to 3 percent slopes, channeled, 700 feet west and 140 feet south of the northeast corner of sec. 36, T. 61 N., R. 33 W.

A1—0 to 12 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; neutral; diffuse smooth boundary.

A2—12 to 25 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few fine and very fine roots; neutral; diffuse smooth boundary.

A3—25 to 37 inches; black (N 2/0) silty clay loam; very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; firm; few very fine roots; neutral; diffuse smooth boundary.

AC—37 to 54 inches; very dark gray (10YR 3/1) silty clay loam; weak medium prismatic structure; firm; few very fine roots; neutral; diffuse smooth boundary.

Cg—54 to 60 inches; dark gray (10YR 4/1) silty clay loam; common fine distinct dark brown (10YR 4/3) mottles; massive; firm; few very fine roots; neutral.

The solum ranges from 36 to 50 inches in thickness. Some pedons have overwash of stratified sediments as much as 18 inches thick.

The A horizon has color value of 2 or 3 and chroma of 0 or 1. It dominantly is silty clay loam but the range includes silt loam. The C horizon has color value of 3 to 5 and chroma of 1. There are few to common mottles of higher value and chroma in the C horizon. In places the solum has a weak structural B horizon.

Gara Series

The Gara series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. The soils formed in glacial till. Slope ranges from 9 to 20 percent.

Gara soils are similar to Shelby soils and commonly are adjacent to Armstrong, Ladoga, and Pershing soils. Unlike Gara soils, Armstrong and Pershing soils have mottles with chroma of 2 in the upper part of the B horizon. Ladoga and Pershing soils do not have glacial sand and pebbles. Armstrong, Ladoga, and Pershing soils have more clay in the B horizon and are in positions above Gara soils. Shelby soils have a mollic epipedon.

Typical pedon of Gara loam, 14 to 20 percent slopes, 1,320 feet east and 102 feet north of the southwest corner of sec. 16, T. 61 N., R. 31 W.

A—0 to 7 inches; very dark grayish brown (10YR 3/2) loam; grayish brown (10YR 5/2) dry; weak very fine granular structure; very friable; many fine to coarse roots; few fine pebbles; medium acid; abrupt smooth boundary.

E—7 to 10 inches; grayish brown (10YR 5/2) loam; weak medium platy structure; very friable; many fine to coarse roots; few fine pebbles; medium acid; abrupt smooth boundary.

Bt1—10 to 13 inches; brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; firm; many fine to coarse roots; few fine pebbles; few faint clay films; grayish brown (10YR 5/2) silt coatings on faces of peds; medium acid; clear smooth boundary.

Bt2—13 to 21 inches; dark yellowish brown (10YR 4/4) clay loam; strong very fine and fine angular blocky structure; firm; many fine to coarse roots; common distinct clay films; few fine pebbles; strongly acid; gradual smooth boundary.

Bt3—21 to 31 inches; dark yellowish brown (10YR 4/6) clay loam; few fine and medium prominent grayish brown (2.5Y 5/2) mottles; moderate fine subangular blocky structure; firm; common fine and medium roots; common faint clay films; few fine pebbles; strongly acid; gradual smooth boundary.

Bt4—31 to 41 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct grayish brown (10YR 5/2) mottles; moderate medium and coarse angular blocky and subangular blocky structure; firm; common fine and very fine roots; few faint clay films; few fine pebbles; slightly acid; clear smooth boundary.

C—41 to 60 inches; yellowish brown (10YR 5/4) clay loam; many medium prominent light brownish gray (2.5Y 6/2) mottles; massive; firm; few very fine roots; many soft calcium masses and concretions; few fine pebbles; strong effervescence; mildly alkaline.

The solum ranges from 36 to 60 inches in thickness.

The A horizon has chroma of 1 or 2. It is loam or clay loam. The B horizon has color value of 4 or 5 and chroma of 3 to 6.

Grundy Series

The Grundy series consists of deep, somewhat poorly drained, slowly permeable soils on loess-covered uplands. The soils formed in noncalcareous loess. Slope ranges from 2 to 9 percent.

Grundy soils are similar to Lagonda and Lamoni soils and commonly are adjacent to Clarinda, Lagonda, Lamoni, and Nevin soils. Clarinda soils contain more clay than Grundy soils, are poorly drained, and are in positions below Grundy soils. Lagonda soils contain more than 5 percent sand in the lower part of the solum. Lamoni soils have glacial sand and pebbles throughout the solum. Nevin soils have a thicker mollic epipedon, contain less clay in the B horizon, and are on terraces below Grundy soils.

Typical pedon of Grundy silt loam, 2 to 5 percent slopes, 255 feet north and 500 feet west of the southeast corner of sec. 34, T. 61 N., R. 32 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine and medium roots; slightly acid; clear smooth boundary.

A—6 to 12 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate very fine subangular blocky structure; friable; common fine and medium roots; slightly acid; clear smooth boundary.

Bt1—12 to 16 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine faint brown (10YR 4/3) mottles; moderate very fine subangular blocky structure; firm; common fine and medium roots; few faint clay films; slightly acid; clear smooth boundary.

Bt2—16 to 21 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; slightly acid; clear smooth boundary.

Bt3—21 to 29 inches; dark grayish brown (10YR 4/2) silty clay; common fine distinct yellowish brown (10YR 5/4), common fine faint grayish brown (10YR 5/2), and few fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; few fine and very fine roots; few fine black (10YR 2/1) concretions of iron and manganese oxides; common distinct clay films; neutral; gradual smooth boundary.

Bt4—29 to 38 inches; grayish brown (2.5Y 5/2) silty clay; common fine prominent yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; firm; few fine and very fine roots; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; common distinct clay films; neutral; gradual smooth boundary.

Bt5—38 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium prominent yellowish brown (10YR 5/4) mottles; weak medium prismatic structure; firm; few fine and very fine roots; common fine tubular pores with dark coatings; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; few faint clay films; neutral; gradual smooth boundary.

C—50 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common medium prominent yellowish brown (10YR 5/4) mottles; massive; firm; common fine tubular pores with dark coatings; neutral.

The solum ranges from 40 to 60 inches in thickness. The mollic epipedon ranges from 11 to 18 inches in thickness.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. Texture is silt loam or silty clay loam. The Bt horizon has color value of 3 to 5. The upper 20 inches of the argillic horizon averages 42 to 48 percent clay.

Grundy silty clay loam, 2 to 5 percent slopes, eroded, and Grundy silty clay loam, 5 to 9 percent slopes, eroded, have a thinner dark A horizon than that defined for the Grundy series, but this difference does not significantly affect the usefulness or behavior of the soils.

Humeston Series

The Humeston series consists of deep, poorly drained, very slowly permeable soils on low terraces. The soils formed in silty alluvial sediment. Slope ranges from 0 to 2 percent.

Humeston soils are similar to Arbela soils and commonly are adjacent to Colo, Nodaway, and Zook soils. Arbela soils are lighter colored in the upper part of the B horizon and generally have less clay and higher chroma in the B horizon than Humeston soils. Colo, Nodaway, and Zook soils do not have an E horizon. Nodaway soils are lighter colored. Colo, Nodaway, and Zook soils are on bottom lands below Humeston soils. Colo soils also are along small drainageways adjacent to Humeston soils.

Typical pedon of Humeston silt loam, 275 feet south and 500 feet east of the northwest corner of sec. 30, T. 62 N., R. 32 W.

Ap—0 to 7 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine and very fine roots; medium acid; abrupt smooth boundary.

A—7 to 13 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; medium acid; clear smooth boundary.

E—13 to 22 inches; dark gray (10YR 4/1) silt loam; weak fine subangular blocky structure parting to weak thin platy; friable; common fine and very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; strongly acid; clear smooth boundary.

BE—22 to 28 inches; very dark gray (10YR 3/1) silty clay loam; weak medium prismatic structure; firm; few very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt1—28 to 39 inches; very dark gray (10YR 3/1) silty clay; weak fine subangular blocky structure; very firm; few very fine roots; light gray (10YR 7/1) silt coatings on faces of peds; few distinct clay films; very few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; strongly acid; gradual smooth boundary.

Bt2—39 to 47 inches; very dark gray (10YR 3/1) silty clay; weak fine subangular blocky structure; very firm; few very fine roots; common distinct clay films; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid; clear smooth boundary.

BCg—47 to 60 inches; dark gray (10YR 4/1) silty clay loam; common fine prominent olive brown (2.5Y 4/4) mottles; weak fine subangular blocky structure; firm; very few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid.

The solum typically is more than 5 feet thick. The combined thickness of the A and E horizons ranges from 20 to 25 inches.

The A horizon has color value of 2 or 3 and chroma of 1. The Bt horizon has color value of 2 or 3 and chroma of 0 or 1. It is silty clay loam or silty clay.

Kennebec Series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on flood plains. The soils formed in silty alluvial sediment. Slope ranges from 0 to 2 percent.

Kennebec soils are commonly adjacent to Colo and Zook soils. Colo soils are poorly drained and contain more clay throughout than Kennebec soils. Colo soils are on bottom lands farther from the original stream channel than Kennebec soils or in small drainageways that widen to meet larger streams where the Kennebec soils occur. Zook soils have more clay throughout and are farther from the original stream channel than Kennebec soils.

Typical pedon of Kennebec silt loam, 380 feet north and 1,980 feet east of the southwest corner of sec. 25, T. 61 N., R. 33 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine and very fine roots; slightly acid; abrupt smooth boundary.

A1—8 to 20 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure parting to weak fine and very fine granular; friable; common fine pores; few fine and very fine roots; few fine wormholes; slightly acid; gradual smooth boundary.

A2—20 to 38 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine pores; few fine and very fine roots; common fine wormholes; slightly acid; diffuse smooth boundary.

AC—38 to 49 inches; very dark brown (10YR 2/2) silt loam; weak fine subangular blocky structure; friable; many fine and medium pores; few very fine roots; common fine wormholes; slightly acid; diffuse smooth boundary.

C—49 to 60 inches; very dark brown (10YR 2/2) silt loam; few fine faint dark brown (10YR 3/3) mottles;

massive; friable; many fine and medium pores; few very fine roots; common fine wormholes; neutral.

The solum and mollic epipedon are more than 36 inches thick. The reaction of the soil is slightly acid or neutral, but in places the upper part of the A horizon is medium acid. Some pedons have an overwash of sediments having color value of 3 or 4. In some pedons, color value increases gradually by 1 or 2 units with depth below the A2 horizon, but chroma remains 1 or 2 to a depth of 5 feet or more.

The A and C horizons commonly have hue of 10YR, but in some pedons the C horizon has hue of 2.5Y. The A and C horizons average 24 to 30 percent clay, but below a depth of 40 inches the clay content is variable. The C horizon contains a few fine concretions or fine faint to distinct mottles.

Ladoga Series

The Ladoga series consists of deep, moderately well drained, moderately slowly permeable soils on loess-covered uplands. The soils formed in noncalcareous loess. Slope ranges from 5 to 9 percent.

Ladoga soils are similar to Pershing and Sharpsburg soils and commonly are adjacent to Armstrong, Gara, and Vanmeter soils. Unlike Ladoga soils, Armstrong and Gara soils contain glacial sand and pebbles. Armstrong soils are in positions below Ladoga soils. Pershing soils have higher clay content in the Bt horizon, and depth to mottles or colors of low chroma is less. Sharpsburg soils have a mollic epipedon. Vanmeter soils are moderately deep to calcareous shale and are in positions below Ladoga soils.

Typical pedon of Ladoga silt loam, 5 to 9 percent slopes, 400 feet south and 400 feet west of the northeast corner of sec. 14, T. 61 N., R. 31 W.

A—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; common fine and very fine roots; slightly acid; abrupt smooth boundary.

E—6 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak thin platy structure parting to moderate very fine subangular blocky; friable; common fine and very fine roots; slightly acid; abrupt smooth boundary.

BE—8 to 11 inches; brown (10YR 4/3) silty clay loam; weak fine subangular blocky structure; firm; few fine and very fine roots; few faint clay films; dark grayish brown (10YR 4/2) silt coatings on faces of peds; medium acid; clear smooth boundary.

Bt1—11 to 18 inches; brown (10YR 4/3) silty clay loam; moderate fine subangular and angular blocky structure; firm; few fine and very fine roots; common distinct clay films; strongly acid; gradual smooth boundary.

Bt2—18 to 27 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine distinct grayish brown (10YR 5/2) mottles; moderate medium and fine subangular blocky structure; firm; few fine and very fine roots; common distinct clay films; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; strongly acid; gradual smooth boundary.

Bt3—27 to 46 inches; yellowish brown (10YR 5/4) silty clay loam; few fine distinct grayish brown (10YR 5/2) mottles; weak medium prismatic structure parting to weak fine and medium subangular blocky; firm; few very fine roots; common distinct clay films; many dark coatings in small channels and cracks; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; strongly acid; gradual smooth boundary.

C—46 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; common fine prominent yellowish red (5YR 5/6) and common fine distinct grayish brown (10YR 5/2) mottles; massive; firm; few very fine roots; many dark coatings in small channels and cracks; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid.

The solum ranges from 40 to 60 inches in thickness. The dark surface layer ranges from 6 to 9 inches in thickness.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is silt loam or silty clay loam. The E horizon has color value of 4 or 5. In cultivated or eroded areas, the E horizon has been incorporated into the Ap horizon and is evident only by silt coatings on peds. The B horizon has color value of 4 or 5 and chroma of 3 or 4. It is silty clay loam or silty clay. The C horizon has chroma of 3 or 4.

Lagonda Series

The Lagonda series consists of deep, somewhat poorly drained, slowly permeable soils on loess-covered uplands. The soils formed in 20 to 36 inches of loess and silty sediment underlain by material washed from glacial till. Slope ranges from 5 to 9 percent.

These soils typically have a thinner dark A horizon than that defined for the Lagonda series, but this difference does not affect the usefulness or behavior of the soils.

Lagonda soils are similar to Grundy and Lamoni soils and commonly are adjacent to those soils. Grundy soils have less sand throughout the solum than Lagonda soils. Lamoni soils contain glacial sand and pebbles throughout the solum.

Typical pedon of Lagonda silty clay loam, 5 to 9 percent slopes, eroded, 1,770 feet north and 225 feet east of the southwest corner of sec. 34, T. 63 N., R. 32 W.

Ap—0 to 6 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; many fine and very fine roots; medium acid; clear smooth boundary.

BA—6 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; many fine and very fine roots; very dark gray (10YR 3/1) organic coatings on faces of peds; common fine black (10YR 2/1) concretions of iron and manganese oxides; medium acid; clear smooth boundary.

Bt1—13 to 26 inches; dark grayish brown (2.5Y 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; firm; common fine and very fine roots; common distinct clay films; few medium black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid; clear smooth boundary.

2Bt2—26 to 36 inches; dark grayish brown (10YR 4/2) silty clay loam; many medium distinct dark yellowish brown (10YR 4/4) and common fine prominent yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure; firm; few fine and very fine roots; many distinct clay films; common medium black (10YR 2/1) stains and concretions of iron and manganese oxides; few fine sand grains; neutral; clear smooth boundary.

2Bt3—36 to 51 inches; gray (10YR 5/1) clay loam; many medium prominent yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure; firm; few fine and very fine roots; common medium black (10YR 2/1) stains and concretions of iron and manganese oxides; common fine sand grains and pebbles; neutral; clear smooth boundary.

3Cg—51 to 60 inches; grayish brown (2.5Y 5/2) clay; many medium prominent dark yellowish brown (10YR 4/6) mottles; massive; very firm; common medium black (10YR 2/1) stains and concretions of iron and manganese oxides; many fine and medium sand grains and pebbles; neutral.

The solum ranges from 40 to 60 inches in thickness. The dark surface layer ranges from 4 to 9 inches in thickness. The depth to a marked increase in content of sand ranges from 20 to 36 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It dominantly is silty clay loam but the range includes silt loam. The B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 1 to 3.

Lamoni Series

The Lamoni series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. The soils formed in weathered glacial till. Slope ranges from 5 to 9 percent.

Lamoni soils are similar to Grundy and Lagonda soils and commonly are adjacent to Grundy, Lagonda, and Shelby soils. Grundy soils have less sand than Lamoni soils and do not have pebbles in the solum. Lagonda soils also have less sand, and they do not have pebbles in the upper part of the B horizon. Shelby soils have less clay and are not so gray in the upper part of the B horizon. They are in positions below Lamoni soils.

Typical pedon of Lamoni loam, 5 to 9 percent slopes, 990 feet east and 740 feet south of the northwest corner of sec. 10, T. 61 N., R. 31 W.

A—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine and very fine roots; strongly acid; clear smooth boundary.

AB—7 to 12 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; common fine and very fine roots; faces of some peds are very dark gray (10YR 3/1); strongly acid; clear smooth boundary.

2Bt1—12 to 18 inches; dark grayish brown (10YR 4/2) clay; common fine distinct dark yellowish brown (10YR 4/4) and few fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; common fine and very fine roots; common fine pebbles; faces of some peds are very dark grayish brown (10YR 3/2); common distinct clay films; strongly acid; clear smooth boundary.

2Bt2—18 to 26 inches; dark grayish brown (10YR 4/2) clay; many medium distinct dark yellowish brown (10YR 4/4) and few fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; very firm; few fine and very fine roots; common fine pebbles; common distinct clay films; strongly acid; gradual smooth boundary.

2Bt3—26 to 36 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) clay; weak medium prismatic structure parting to weak medium subangular blocky; very firm; few fine and very fine roots; common fine pebbles; common distinct clay films; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

2Bt4—36 to 53 inches; yellowish brown (10YR 5/6) clay loam; common fine prominent gray (5Y 6/1) mottles; weak medium prismatic structure; firm; few very fine roots; common fine pebbles; few faint clay films; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

2C—53 to 60 inches; gray (5Y 6/1) clay loam; many medium prominent yellowish brown (10YR 5/6) and common fine prominent brown (7.5YR 4/4) mottles; massive; firm; common fine pebbles; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid.

The solum ranges from 44 to 60 inches in thickness. The mollic epipedon ranges from 10 to 13 inches in thickness.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The B horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 to 6. The C horizon is highly mottled in hue of 5YR to 5Y, value of 4 to 6, and chroma of 1 to 8.

Lamoni clay loam, 5 to 9 percent slopes, eroded, has a thinner dark A horizon than that defined for the Lamoni series, but this difference does not significantly affect the usefulness or behavior of the soil.

Nevin Series

The Nevin series consists of deep, somewhat poorly drained, moderately permeable soils on low stream terraces. The soils formed in silty alluvial sediment. Slope ranges from 0 to 2 percent.

Nevin soils commonly are adjacent to Bremer, Colo, Grundy, Nodaway, and Zook soils. Bremer soils have lower chroma in the B horizon than Nevin soils and are on the more level parts of low stream terraces. Colo soils have a mollic epipedon 36 inches or more thick and are generally in positions below Nevin soils. Grundy soils have a thinner mollic epipedon, contain more clay in the B horizon, and are in positions above Nevin soils. Nodaway soils do not have a mollic epipedon. Zook soils have a mollic epipedon 36 inches or more thick and are fine textured. Nodaway and Zook soils are in positions below Nevin soils.

Typical pedon of Nevin silt loam, 425 feet north and 375 feet east of the southwest corner of sec. 9, T. 63 N., R. 32 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; few fine and very fine roots; slightly acid; clear smooth boundary.

A—8 to 16 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; few fine and very fine roots; slightly acid; clear smooth boundary.

AB—16 to 24 inches; very dark gray (10YR 3/1) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure; friable; few fine and very fine roots; slightly acid; clear smooth boundary.

Bt1—24 to 29 inches; dark grayish brown (10YR 4/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; few fine and very fine roots; very dark grayish brown (10YR 3/2) coatings on faces of peds; few faint clay films; common medium black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

Bt2—29 to 38 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/4) mottles; weak fine and medium prismatic structure parting to weak fine subangular blocky; firm; few fine and very fine roots; very dark grayish brown (10YR 3/2) coatings on faces of peds; few distinct clay films; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

Bt3—38 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/4) and common fine prominent dark yellowish brown (10YR 4/6) mottles; moderate medium prismatic structure; firm; few very fine and fine roots; very dark grayish brown (10YR 3/2) coatings on faces of peds; few distinct clay films; common fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

C—50 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine and medium prominent yellowish brown (10YR 5/6) and common fine prominent dark yellowish brown (10YR 4/6) mottles; massive; firm; very dark grayish brown (10YR 3/2) coatings along tubular pores and old root channels; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; neutral.

The solum ranges from 45 to 50 inches in thickness. The mollic epipedon ranges from 19 to 30 inches in thickness.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B and C horizons have hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. The C horizon is dominantly silty clay loam, but some Nevin soils have a stratified, medium textured or moderately fine textured C horizon.

Nodaway Series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on flood plains. The soils formed in silty alluvial sediment. Slope ranges from 0 to 2 percent.

Nodaway soils commonly are adjacent to Colo and Zook soils. Colo soils have a thick mollic epipedon, are poorly drained, and are farther from the original stream channel than Nodaway soils. Zook soils have a thick mollic epipedon, are more clayey, are poorly drained, and are in nearly level or depressional areas farther from the original stream channel.

Typical pedon of Nodaway silt loam, 1,550 feet east and 500 feet north of the southwest corner of sec. 11, T. 61 N., R. 30 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; common fine and very fine roots; neutral; clear smooth boundary.

C—8 to 60 inches; stratified dark grayish brown (10YR 4/2), very dark grayish brown (10YR 3/2), very dark gray (10YR 3/1), brown (10YR 5/3), and grayish brown (10YR 5/2) silt loam; appears massive but has weak bedding planes; friable; numerous wormholes and root channels; few to common fine and very fine roots; few fine black (10YR 2/1) stains; neutral.

The A horizon has color value of 3 and chroma of 1 or 2. The sequence and thickness of strata in the C horizon are varied. Color value is 3 to 5 and chroma is 1 to 3. There are some very thin lenses of material coarser than silt loam above a depth of 40 inches. Some pedons are sandy below a depth of 40 inches.

A dark colored, medium textured or moderately fine textured buried soil is below a depth of 36 inches in some pedons.

Olmitz Series

The Olmitz series consists of deep, moderately well drained, moderately permeable soils on foot slopes. They formed in loamy local alluvium derived from glacial till. Slope ranges from 2 to 5 percent.

Olmitz soils commonly are adjacent to Shelby, Wabash, and Zook soils. Shelby soils have an argillic horizon and a thinner mollic epipedon than Olmitz soils. Shelby soils are in positions above Olmitz soils. Wabash soils are very poorly drained, and Zook soils are poorly drained. Wabash and Zook soils contain more clay than Olmitz soils and are on bottom lands below Olmitz soils.

Typical pedon of Olmitz loam, 2 to 5 percent slopes, 930 feet west and 246 feet south of the northeast corner of sec. 5, T. 63 N., R. 32 W.

Ap—0 to 7 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common very fine and fine roots; slightly acid; clear smooth boundary.

A1—7 to 12 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; common very fine and fine roots; slightly acid; gradual smooth boundary.

A2—12 to 21 inches; black (10YR 2/1) clay loam, very dark grayish brown (10YR 3/2) kneaded, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; common very fine and fine roots; slightly acid; gradual smooth boundary.

AB—21 to 29 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; friable; common very fine and fine roots; some peds have very dark brown (10YR 2/2) organic coatings; slightly acid; gradual smooth boundary.

Bw—29 to 41 inches; dark brown (10YR 3/3) clay loam, dark brown (10YR 4/3) kneaded; weak medium prismatic structure; friable; few very fine roots; some peds have very dark grayish brown (10YR 3/2) organic coatings; slightly acid; gradual smooth boundary.

BC—41 to 49 inches; dark brown (10YR 3/3) clay loam, dark yellowish brown (10YR 4/4) kneaded; weak medium prismatic structure; friable; few very fine roots; common fine and very fine tubular pores; slightly acid; gradual smooth boundary.

C—49 to 60 inches; brown (10YR 4/3) clay loam, dark yellowish brown (10YR 4/4) kneaded; massive; friable; common very fine tubular pores; common pebbles 2 to 5 mm in size in upper part; few fine black (10YR 2/1) concretions of iron and manganese oxides; slightly acid.

The solum ranges from 43 to 60 inches in thickness. The solum typically is slightly acid or medium acid.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The B and C horizons have color value of 3 or 4 and chroma of 2 to 4. A few mottles are present in the lower part of the B horizon or in the C horizon in some pedons.

Pershing Series

The Pershing series consists of deep, somewhat poorly drained, slowly permeable soils on loess-covered uplands. The soils formed in noncalcareous loess. Slope ranges from 2 to 9 percent.

Pershing soils are similar to Armstrong and Ladoga soils and commonly are adjacent to Armstrong and Gara soils. Unlike Pershing soils, Armstrong and Gara soils contain glacial sand and pebbles. Gara soils contain less clay and are in positions below Pershing soils. Ladoga soils have less clay in the B horizon and do not have mottles with chroma of 2 in the upper part of the B horizon.

Typical pedon of Pershing silt loam, 2 to 5 percent slopes, 1,900 feet south and 1,320 feet west of the northeast corner of sec. 33, T. 62 N., R. 30 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak very fine granular; friable; many fine and very fine roots; slightly acid; abrupt smooth boundary.

E—8 to 14 inches; dark grayish brown (10YR 4/2) silt loam; weak thin platy structure parting to weak fine granular; friable; many fine and very fine roots; light brownish gray (10YR 6/2) silt coatings on faces of peds; strongly acid; clear smooth boundary.

Bt1—14 to 25 inches; brown (10YR 4/3) silty clay; common fine distinct yellowish brown (10YR 5/6) and common fine faint dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; firm; common fine and very fine roots; few faint clay films; very dark grayish brown (10YR 3/2) organic coatings on faces of peds; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; strongly acid; clear smooth boundary.

Bt2—25 to 36 inches; brown (10YR 4/3) silty clay; common fine distinct yellowish brown (10YR 5/6) and common fine faint dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; firm; common fine and very fine roots; common distinct clay films; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Bt3—36 to 45 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine and medium prominent yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; weak fine prismatic structure parting to weak fine subangular blocky; firm; few fine and very fine roots; few distinct clay films; weak fine black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

BC—45 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine and medium prominent yellowish brown (10YR 5/6) mottles; weak medium and coarse prismatic structure; firm; few fine and very fine roots; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid.

The solum typically is 60 inches or more thick. The dark surface layer ranges from 6 to 8 inches in thickness.

The A horizon is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1). It is silt loam or silty clay loam. Where the soil has been eroded or cultivated, all of the E horizon has been mixed into the Ap horizon. The B horizon has hue of 2.5Y or 10YR, value of 4 to 6, and chroma of 2 to 6. Some pedons contain glacial sand or pebbles in the lower part of the solum.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained, moderately slowly permeable soils on loess-covered uplands. The soils formed in noncalcareous silty loess. Slope ranges from 2 to 5 percent.

Sharpsburg soils are similar to Ladoga soils and commonly are adjacent to Grundy and Lamoni soils. Grundy soils have chroma of 2 in the upper part of the B horizon and generally are in positions below Sharpsburg soils. Ladoga soils do not have a mollic epipedon. Lamoni soils have chroma of 2 in the upper part of the B horizon, contain glacial sand and pebbles throughout the solum, and are in positions below Sharpsburg soils.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, 75 feet north and 1,345 feet west of the southeast corner of sec. 36, T. 64 N., R. 33 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate fine angular blocky structure parting to moderate fine granular; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

A—7 to 15 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

Bt1—15 to 22 inches; brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; firm; common fine and very fine roots; very dark grayish brown (10YR 3/2) organic coatings on faces of peds; few faint clay films; medium acid; clear smooth boundary.

Bt2—22 to 33 inches; brown (10YR 4/3) silty clay loam; common fine faint grayish brown (10YR 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; common fine and very fine roots; common distinct clay films; few medium black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

Bt3—33 to 46 inches; dark yellowish brown (10YR 4/4) silty clay loam; common medium prominent grayish brown (2.5Y 5/2) and common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium prismatic structure parting to weak fine and medium subangular blocky; firm; common fine and very fine roots; common distinct clay films; common medium black (10YR 2/1) stains and concretions of iron and manganese oxides; medium acid; gradual smooth boundary.

BC—46 to 57 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure; firm; few fine and very fine roots; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

C—57 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; many fine and medium prominent yellowish brown (10YR 5/4) and few fine prominent strong brown (7.5YR 5/6) mottles; massive; firm; few fine black (10YR 2/1) stains and concretions of iron and manganese oxides; slightly acid.

The solum ranges from 42 to 57 inches in thickness. The mollic epipedon ranges from 10 to 15 inches in thickness.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. Mollic colors usually extend into the upper part of the B horizon. The upper part of the Bt horizon is brown or dark brown (10YR 4/3) or dark yellowish brown (10YR 4/4). The lower part of the Bt horizon has color value of 4 or 5 and chroma of 2 to 4. The Bt horizon dominantly is silty clay loam, but the range includes silty clay. The BC and C horizons have hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4.

Shelby Series

The Shelby series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. The soils formed in glacial till. Slope ranges from 9 to 20 percent.

Shelby soils are similar to Gara soils and commonly are adjacent to Colo and Lamoni soils. Unlike Shelby soils, Colo soils have a thicker mollic epipedon, contain less sand and pebbles, and are below Shelby soils in narrow drainageways that branch into the uplands. Gara soils do not have a mollic epipedon. Lamoni soils have a fine textured B horizon with matrix of 2 chroma in the upper part. They are in positions above Shelby soils.

Typical pedon of Shelby loam, 9 to 14 percent slopes, 1,213 feet south and 804 feet east of the northwest corner of sec. 14, T. 62 N., R. 33 W.

A—0 to 7 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak fine granular structure; friable; common fine and very fine roots; medium acid; clear smooth boundary.

AB—7 to 12 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; common fine and very fine roots; strongly acid; clear smooth boundary.

Bt1—12 to 16 inches; dark brown (10YR 3/3) clay loam; a few peds are brown (10YR 4/3); moderate fine subangular blocky structure; firm; common fine pebbles; common fine and very fine roots; very dark gray (10YR 3/1) coatings on faces of most peds; few faint clay films; strongly acid; clear smooth boundary.

Bt2—16 to 22 inches; brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; firm; common fine pebbles; few fine and very fine roots; very dark grayish brown (10YR 3/2) coatings on faces of some peds; common distinct clay films; strongly acid; clear smooth boundary.

Bt3—22 to 33 inches; yellowish brown (10YR 5/4) clay loam; few fine prominent grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; common fine and medium pebbles; few fine and very fine roots; few distinct clay films; medium acid; abrupt smooth boundary.

C1—33 to 42 inches; yellowish brown (10YR 5/4) clay loam; common fine prominent grayish brown (2.5Y 5/2) mottles; massive; firm; common fine and medium pebbles; few very fine roots; few black (10YR 2/1) stains; common fine and medium white (10YR 8/1) concretions and soft masses of calcium carbonate; strong effervescence; mildly alkaline; clear smooth boundary.

C2—42 to 60 inches; olive (5Y 5/3) clay loam; common medium prominent yellowish brown (10YR 5/6) mottles; massive; firm; common fine and medium pebbles; few black (10YR 2/1) stains; common fine and medium soft masses and concretions of calcium carbonate; strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 30 to 49 inches. The thickness of the mollic epipedon ranges from 10 to 18 inches.

The A horizon has color value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The B horizon has color value of 3 to 5 and chroma of 3 or 4. Some pedons have mottles with chroma of 2 in the lower part of the B horizon. The C horizon has hue of 7.5YR to 5Y, value of 4 to 6, and chroma of 2 to 6. It is highly mottled.

Shelby clay loam, 9 to 14 percent slopes, eroded, and Shelby clay loam, 14 to 20 percent slopes, eroded, have a thinner dark A horizon than that defined for the Shelby series, but this difference does not significantly affect the usefulness or behavior of the soils.

Vanmeter Series

The Vanmeter series consists of moderately deep, moderately well drained, very slowly permeable soils on uplands. The soils formed in residuum of calcareous shale. Slope ranges from 14 to 40 percent.

Vanmeter soils commonly are adjacent to Armstrong, Gara, and Ladoga soils. Those soils are deep and are in positions above Vanmeter soils. Armstrong and Gara soils formed in glacial till, and Ladoga soils formed in loess.

Typical pedon of Vanmeter flaggy silty clay loam, 14 to 40 percent slopes, 300 feet north and 2,541 feet east of the southwest corner of sec. 17, T. 61 N., R. 30 W.

A1—0 to 3 inches; very dark gray (10YR 3/1) flaggy silty clay loam, gray (10YR 5/1) dry; weak fine granular structure; friable; many very fine to few coarse roots; approximately 15 percent limestone fragments; slight effervescence; mildly alkaline; clear smooth boundary.

A2—3 to 6 inches; dark grayish brown (10YR 4/2) flaggy silty clay loam; weak fine angular blocky and subangular blocky structure parting to weak fine granular; friable; many very fine to few coarse roots;

coarse fragments approximately same as A1; slight effervescence; mildly alkaline; clear smooth boundary.

Bw1—6 to 18 inches; brown (7.5YR 4/4) silty clay; moderate fine subangular blocky structure; firm; common very fine to few coarse roots; approximately 10 percent limestone fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Bw2—18 to 23 inches; olive brown (2.5Y 4/4) silty clay; moderate fine subangular blocky structure; firm; few very fine to medium roots; slight effervescence; mildly alkaline; clear smooth boundary.

BC—23 to 28 inches; grayish brown (2.5Y 5/2) silty clay; weak thin platy structure parting to weak fine subangular blocky; firm; few very fine to medium roots; about 15 percent shale fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

Cr—28 to 60 inches; grayish brown (2.5Y 5/2) soft clay shale; strong effervescence; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. Shale and limestone fragments make up 0 to 15 percent, by volume, of the solum. The soil is generally calcareous and mildly alkaline or moderately alkaline throughout, but some pedons are noncalcareous and neutral to a depth of about 12 inches.

The B horizon has hue of 5Y to 7.5YR, value of 4 or 5, and chroma of 2 to 4.

Wabash Series

The Wabash series consists of deep, very poorly drained, very slowly permeable soils on wide flood plains. The soils formed in fine-textured alluvial sediment. Slope ranges from 0 to 1 percent.

Wabash soils are similar to, and commonly are adjacent to, Zook soils. Zook soils contain less clay in the control section than Wabash soils.

Typical pedon of Wabash silty clay, 1,518 feet west and 153 feet north of the southeast corner of sec. 15, T. 63 N., R. 32 W.

Ap—0 to 5 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak fine granular structure; firm; common fine and very fine roots; neutral; abrupt smooth boundary.

A1—5 to 9 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; firm; common fine and very fine roots; neutral; clear smooth boundary.

A2—9 to 18 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; firm; common fine and very fine roots; neutral; clear smooth boundary.

Bg1—18 to 28 inches; black (N 2/0) silty clay, very dark gray (10YR 3/1) dry; few fine prominent dark brown (10YR 3/3) mottles; moderate medium subangular blocky structure; very firm; few very fine roots; neutral; gradual smooth boundary.

Bg2—28 to 60 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; few fine faint grayish brown (10YR 5/2) and few fine distinct very dark grayish brown (2.5Y 3/2) mottles; moderate medium subangular blocky structure; very firm; few very fine roots; mildly alkaline.

The solum ranges from 40 inches to 60 inches or more in thickness. Color value of 3 or lower extends into the B horizon.

The A horizon has value of 2 or 3 and chroma of 2 or less. It dominantly is silty clay, but the range includes silty clay loam. The B horizon has hue of 10YR to 5Y or is neutral; value is 2 to 4, and chroma is 0 or 1.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on flood plains. The soils formed in alluvial sediment. Slope ranges from 0 to 1 percent.

Zook soils are similar to Colo and Wabash soils and commonly are adjacent to Colo, Nodaway, and Wabash soils. Colo soils contain less clay in the solum than Zook soils. Nodaway soils are moderately well drained, contain less clay, do not have a mollic epipedon, and are on higher, undulating areas closer to stream and river channels. Wabash soils contain more clay in the solum.

Typical pedon of Zook silty clay loam, 2,295 feet east and 2,474 feet south of the northwest corner of sec. 15, T. 63 N., R. 32 W.

Ap—0 to 6 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common fine and very fine roots; slightly acid; clear smooth boundary.

A1—6 to 15 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine and very fine roots; slightly acid; gradual smooth boundary.

A2—15 to 21 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; firm; few very fine roots; slightly acid; gradual smooth boundary.

A3—21 to 30 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; firm; few very fine roots; few fine black (10YR 2/1) concretions of iron and manganese oxides; slightly acid; clear smooth boundary.

Bg—30 to 50 inches; very dark gray (10YR 3/1) silty clay; moderate medium subangular blocky structure; firm; few very fine roots; dark coatings along tubular pores and old root channels; few fine black (10YR

2/1) concretions of iron and manganese oxides; slightly acid; gradual smooth boundary.

Cg—50 to 60 inches; dark gray (10YR 4/1) silty clay; few fine distinct dark yellowish brown (10YR 4/4) mottles; massive; firm; dark coatings along tubular pores and old root channels; few fine black (10YR 2/1) concretions of iron and manganese oxides; neutral.

The thickness of the solum and of the mollic epipedon ranges from 40 to 50 inches. The thickness of the A horizon ranges from 29 to 40 inches.

The A horizon has chroma of 1 or 0. It is dominantly silty clay loam, but the range includes silty clay. The B horizon has color value of 3 or 4. The C horizon has color value of 3 to 5. Some pedons have mottles below a depth of 36 inches.

Formation of the Soils

Soil is the product of soil-forming processes acting on accumulated or deposited geologic materials. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and has existed since accumulation, the plant and animal life on and in the soil, the relief, or lay of the land, and the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and in extreme cases determines it almost entirely. Finally, time is needed for parent material to change into a soil that has distinct horizons. Although it varies, some time is always required for differentiation of soil horizons. Generally, a long time is required for distinct horizons to form.

The factors of soil formation are so closely interrelated in their effect on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the other four.

Plants and Animals

Plants, insects and other animals (especially ones that dig burrows), bacteria, and fungi are important in the formation of soil. They affect the organic matter, plant nutrients, structure, and porosity of the soils.

Many of the soils in Gentry County formed when the vegetation was mainly tall prairie grasses. These soils, generally known as prairie soils, have a thick, dark-colored surface layer that has a high content of organic matter because of abundant bacteria and decayed fine grass roots and other organic materials. Clarinda, Grundy, Lagonda, Lamoni, Olmitz, Sharpsburg, and Shelby soils formed under this kind of plant cover.

Several soils in Gentry County have, at different times, supported both prairie and forest. They have properties intermediate between those of soils that formed under grass and those of soils that formed under trees. These soils, generally known as transitional soils, are in the Armstrong, Gara, Ladoga, and Pershing series.

Worms, insects, other burrowing animals, large animals, and man affect and disturb the soils. The kinds of animals in a given area and their activity are determined by the kinds of vegetation.

Bacteria and fungi, however, contribute more toward the formation of soils than do animals. Bacteria and fungi cause decomposition of organic material, improve tilth, and fix nitrogen in the soil. The population of soil organisms is directly related to the rate of decomposition of organic material in the soil.

Man has had a tremendous effect on the soils of this county. Because of intensive cultivation and overgrazing, erosion has been severe in many small areas. As much as 15 inches of topsoil has been lost from these areas. In many areas the soils are still eroding too fast to sustain production.

Climate

Climate has been an important factor in the formation of the soils in Gentry County. In the past one million years variations in the climate have drastically affected the area.

Gentry County has a subhumid midcontinental climate that has changed little in the past 6,500 years. This period has been drier than previous ones and more favorable for native prairie grasses. Most of the soils have dark layers in the upper part of the profile, which indicates that the soils formed under prairie vegetation. Grundy and Shelby soils are examples.

The period between 6,500 years ago and 20,000 years ago was cool and moist. The climate was favorable for forest vegetation. Since that period, the forest vegetation diminished, except in some areas near streams. Some soils in Gentry County have a moderately thick dark surface layer, indicating that the soils formed under transitional prairie-timber vegetation. Armstrong, Gara, Ladoga, and Pershing soils are examples.

Changes in climate caused the glacial periods. Thousands of years of cool temperatures resulted in the massive Nebraskan and Kansan glaciers. Warmer temperatures later resulted in severe geological erosion and the blowing of the loess that covered most of Gentry County at one time. Extreme changes in climate occurred very slowly; therefore, there were long intermediate periods when different types of vegetation grew. Soils formed on the surface and were later covered by loess, truncated, and mixed by erosion or completely washed away. Soils that formed mostly in these old truncated or weathered areas include the Armstrong, Clarinda, and Lamoni soils.

The prevailing winds are from the southwest. Most of the loess, therefore, probably came from the bottom lands of the Missouri River and other large streams. The distance that loess is carried by the wind depends on the size of the particles. Because most of the loess that covered Gentry County was fine silt and clay, the soils that formed in loess have a clayey subsoil. Grundy, Lagonda, and Pershing soils are examples.

Local conditions can modify the influence of the general climate in a region. For example, south-facing slopes are warmer and drier than north-facing slopes. Low-lying, poorly drained soils on bottom lands stay wetter and cooler longer than the soils around them. These local differences influence the characteristics of the soils and account for some of the local differences among them.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineral composition of the soil. In Gentry County, the soils formed in loess, glacial till, alluvium, or residual material or in a combination of these materials.

Loess is wind deposited. It probably was blown from the larger flood plains. Loess remains on most of the wider ridges and is 10 feet thick in some areas. Grundy, Pershing, and Sharpsburg soils formed in loess. Lagonda soils formed in a thin layer of loess and the underlying glacial till.

Prior to the deposition of loess, thick layers of glacial till were laid over the bedrock. This glacial till generally is yellowish brown and is a heterogeneous mass of sand, silt, and clay and rock fragments ranging in size from small pebbles to boulders. The glacial till ranges in thickness from a few feet to more than 300 feet. In most areas, soils formed in the glacial till before the loess was deposited. In some narrow areas, this weathered glacial material was later exposed by geologic erosion and a new surface layer has formed. The new surface layer varies in texture and thickness from place to place. Armstrong and Lamoni soils formed in these areas. In steeper areas, the unweathered glacial material was exposed by geologic erosion at a later time. Gara and Shelby soils formed in this material.

Alluvium is soil material that was transported by water and deposited on the nearly level flood plains of streams. Most of this material came from the surrounding uplands. The material ranges from clay and silt to fine sand. Bremer, Colo, Wabash, and Zook soils formed in the clayey material. Arbela, Humeston, Kennebec, Nevin, and Nodaway soils formed in the more silty material.

Residual material in Gentry County weathered from interbedded shale and limestone. The shale layers generally are thicker than those of limestone and are often below the limestone. Vanmeter soils formed in residual material.

Relief

Relief influences soil formation mostly through its effect on drainage, runoff, and erosion.

The amount of water entering and passing through the soil depends on the steepness of the slope, the permeability of the soil material, and the amount and intensity of rainfall. Because runoff is rapid on steep slopes, very little water passes through the soil, resulting in little development of distinct horizons. Runoff is slight on gently sloping and nearly level soils, and most of the water passes through the soil material. Such soils have maximum profile development.

Because they receive more direct sun, the soils on steep south-facing slopes are generally more droughty than soils that formed in similar material on north-facing slopes. Droughtiness influences soil formation through its effect on the amount and kind of vegetation, erosion, and freezing and thawing.

Time

The degree of profile development reflects the length of time that the parent material has been in place and subject to weathering. Young soils show little profile development or horizon differentiation. Old soils show the effects of clay movement and leaching, and they have distinct horizons.

Alluvial soils are the youngest in Gentry County. Nodaway soils have no profile development because alluvial material is added to the surface nearly every year. Arbela and Humeston soils are the oldest alluvial soils in the survey area. They are on the higher bottom lands and have moderate profile development.

Older than the alluvial soils in the county are the Gara and Shelby soils, which formed on dissected slopes of late Wisconsin age, probably 11,000 to 14,000 years old *(5)*. Grundy, Ladoga, Lagonda, Pershing, and Sharpsburg soils formed in early Wisconsin loess, which is probably 14,000 to 16,000 years old.

Oldest are the Armstrong soils, which formed in weathered material of late Sangamon age *(5)*—about 38,000 years old—and Lamoni soils, which formed in material dating from the Yarmouth interglacial period *(6)*, more than 150,000 years ago.

In places in Gentry County, rocky residual material has been exposed by geologic erosion. This material is very old, but the soils show little profile development because of the steep slopes and moderate depth of the material. The moderately deep Vanmeter soils are an example.

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective cover of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazingland for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual.* The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, alluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Arabic numeral 2 precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to insure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any horizon between the surface layer and the subsoil.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The part of the soil above the B horizon; may include the A, E, AB, and EB horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-79 at Bethany, Mo.]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F		In	In	In		In
January----	33.5	12.8	23.2	61	-19	0	1.03	0.25	1.64	3	9.0
February---	40.5	19.0	29.8	67	-13	12	1.07	.38	1.64	3	5.5
March------	51.1	28.1	39.6	80	0	49	2.43	.98	3.66	6	5.9
April------	66.0	40.9	53.5	87	18	154	3.46	1.77	4.93	7	1.1
May--------	76.1	51.3	63.7	91	30	429	4.31	2.89	5.61	8	.0
June-------	84.7	60.6	72.7	98	43	681	4.43	2.60	6.06	8	.0
July-------	89.4	64.7	77.1	102	47	840	3.85	1.77	5.63	6	.0
August-----	87.4	62.3	74.9	100	46	772	4.45	2.16	6.42	7	.0
September--	79.7	53.5	66.6	96	31	498	4.81	1.58	7.44	6	.0
October----	69.0	42.7	55.9	89	20	230	3.32	.87	5.29	5	.0
November---	52.3	30.5	41.4	76	4	21	1.73	.31	2.82	3	1.6
December---	39.2	20.3	29.8	66	-10	0	1.11	.44	1.66	3	6.5
Yearly---	64.1	40.6	52.4	103	-20	3,686	36.00	28.66	42.39	65	29.6

[1] A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-79 at Bethany, Mo.]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 20	April 27	May 14
2 years in 10 later than--	April 16	April 22	May 9
5 years in 10 later than--	April 8	April 14	April 30
First freezing temperature in fall:			
1 year in 10 earlier than--	October 18	October 3	September 23
2 years in 10 earlier than--	October 23	October 8	September 28
5 years in 10 earlier than--	October 31	October 18	October 7

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-79 at Bethany, Mo.]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	187	167	141
8 years in 10	193	174	147
5 years in 10	205	187	159
2 years in 10	217	201	172
1 year in 10	224	208	178

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
6B	Sharpsburg silty clay loam, 2 to 5 percent slopes	4,540	1.4
10C2	Lagonda silty clay loam, 5 to 9 percent slopes, eroded	3,590	1.1
11B	Grundy silt loam, 2 to 5 percent slopes	29,290	9.3
11C	Grundy silt loam, 5 to 9 percent slopes	5,050	1.6
12B2	Grundy silty clay loam, 2 to 5 percent slopes, eroded	3,330	1.1
12C2	Grundy silty clay loam, 5 to 9 percent slopes, eroded	6,260	2.0
13C2	Clarinda silty clay loam, 5 to 9 percent slopes, eroded	733	0.2
14C	Lamoni loam, 5 to 9 percent slopes	11,620	3.7
15C2	Lamoni clay loam, 5 to 9 percent slopes, eroded	81,310	25.8
16D	Shelby loam, 9 to 14 percent slopes	7,070	2.2
16E	Shelby loam, 14 to 20 percent slopes	1,510	0.5
17D2	Shelby clay loam, 9 to 14 percent slopes, eroded	44,440	14.1
17E2	Shelby clay loam, 14 to 20 percent slopes, eroded	6,560	2.1
19C	Ladoga silt loam, 5 to 9 percent slopes	1,310	0.4
20C2	Ladoga silty clay loam, 5 to 9 percent slopes, eroded	300	0.1
21D	Gara loam, 9 to 14 percent slopes	1,720	0.5
21E	Gara loam, 14 to 20 percent slopes	4,240	1.3
22D2	Gara clay loam, 9 to 14 percent slopes, eroded	6,870	2.2
22E2	Gara clay loam, 14 to 20 percent slopes, eroded	5,460	1.7
23C	Armstrong loam, 5 to 9 percent slopes	2,220	0.7
24C2	Armstrong clay loam, 5 to 9 percent slopes, eroded	10,200	3.2
25B	Pershing silt loam, 2 to 5 percent slopes	2,020	0.6
26C2	Pershing silty clay loam, 5 to 9 percent slopes, eroded	1,110	0.4
33E	Vanmeter flaggy silty clay loam, 14 to 40 percent slopes	6,260	2.0
44	Bremer silty clay loam	3,440	1.1
45	Humeston silt loam	2,170	0.7
46	Arbela silt loam	1,110	0.4
51	Kennebec silt loam	1,670	0.5
52B	Olmitz loam, 2 to 5 percent slopes	2,170	0.7
54	Zook silty clay loam	9,190	2.9
55	Colo silty clay loam	5,860	1.9
56	Nevin silt loam	4,700	1.5
57A	Colo silty clay loam, channeled, 0 to 3 percent slopes	7,370	2.3
58	Wabash silty clay	1,820	0.6
66	Nodaway silt loam	27,520	8.7
88	Pits, quarries	300	0.1
	Water, less than 40 acres	1,110	0.4
	Total	315,443	100.0

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
6B	Sharpsburg silty clay loam, 2 to 5 percent slopes
11B	Grundy silt loam, 2 to 5 percent slopes
12B2	Grundy silty clay loam, 2 to 5 percent slopes, eroded
25B	Pershing silt loam, 2 to 5 percent slopes
44	Bremer silty clay loam (where drained)
45	Humeston silt loam (where drained)
46	Arbela silt loam (where drained)
51	Kennebec silt loam
52B	Olmitz loam, 2 to 5 percent slopes
54	Zook silty clay loam (where drained)
55	Colo silty clay loam (where drained)
56	Nevin silt loam
58	Wabash silty clay (where drained)
66	Nodaway silt loam

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Land capability	Corn	Soybeans	Winter wheat	Grain sorghum	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
6B------------- Sharpsburg	IIe	113	43	43	90	4.7	8.7	4.2
10C2------------ Lagonda	IIIe	80	28	34	65	2.9	7.2	3.8
11B------------- Grundy	IIe	98	38	40	85	4.4	8.8	4.0
11C------------- Grundy	IIIe	90	34	37	77	4.0	8.0	3.9
12B2------------ Grundy	IIIe	94	35	38	80	4.2	8.4	3.9
12C2------------ Grundy	IIIe	80	30	34	68	3.6	7.2	3.8
13C2------------ Clarinda	IVe	55	21	23	46	2.2	3.3	2.3
14C------------- Lamoni	IIIe	76	29	32	65	3.2	4.5	3.0
15C2------------ Lamoni	IIIe	71	27	29	61	3.0	4.3	2.7
16D------------- Shelby	IIIe	84	32	35	73	3.5	5.0	3.3
16E------------- Shelby	IVe	69	26	30	66	2.9	4.1	2.3
17D2------------ Shelby	IVe	81	31	33	67	3.4	4.9	3.3
17E2------------ Shelby	VIe	---	---	27	---	2.7	4.0	2.1
19C------------- Ladoga	IIIe	98	38	40	85	4.5	6.5	4.0
20C2------------ Ladoga	IIIe	90	38	36	78	4.4	6.3	3.9
21D------------- Gara	IVe	78	30	32	66	3.3	4.7	2.7
21E------------- Gara	VIe	---	---	---	---	2.5	3.3	1.7
22D2------------ Gara	IVe	75	28	29	59	3.1	4.5	2.5
22E2------------ Gara	VIe	---	---	---	---	2.2	3.1	1.5
23C------------- Armstrong	IIIe	67	25	30	58	2.7	3.3	2.3
24C2------------ Armstrong	IIIe	59	22	28	57	2.5	3.1	2.1

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Winter wheat	Grain sorghum	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
25B------------- Pershing	IIIe	90	33	36	75	4.2	6.0	3.8
26C2------------ Pershing	IIIe	74	28	31	63	3.8	5.4	3.4
33E------------- Vanmeter	VIIe	---	---	---	---	1.0	1.0	1.0
44-------------- Bremer	IIw	100	40	41	83	4.5	6.3	4.0
45-------------- Humeston	IIIw	88	33	36	79	3.7	5.0	3.3
46-------------- Arbela	IIw	108	41	45	94	4.8	9.6	4.1
51-------------- Kennebec	IIw	112	46	46	96	5.1	7.1	4.2
52B------------- Olmitz	IIe	100	38	41	86	4.2	6.0	3.9
54-------------- Zook	IIw	82	36	34	70	4.0	4.0	4.0
55-------------- Colo	IIw	104	40	42	88	4.2	5.5	4.2
56-------------- Nevin	I	114	43	47	99	4.8	8.0	4.0
57A------------- Colo	Vw	---	---	---	---	---	4.5	3.0
58-------------- Wabash	IIIw	65	32	30	65	2.0	2.0	2.0
66-------------- Nodaway	IIw	110	42	41	85	4.6	6.5	4.0
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* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
19C, 20C2: Ladoga	2o	Slight	Slight	Slight	Slight	White oak Northern red oak	72 78	Eastern white pine, white oak, sugar maple, northern red oak, black walnut.
21D: Gara	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, pin oak, white oak, northern red oak.
21E: Gara	3r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, pin oak, white oak, northern red oak.
22D2: Gara	3o	Slight	Slight	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, pin oak, white oak, northern red oak.
22E2: Gara	3r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	65 65	Eastern white pine, pin oak, white oak, northern red oak.
23C, 24C2: Armstrong	4c	Slight	Slight	Severe	Severe	White oak Northern red oak	55 55	Eastern white pine, white oak, northern red oak, pin oak, green ash.
25B, 26C2: Pershing	4c	Slight	Slight	Severe	Severe	White oak	55	Eastern white pine, pin oak, green ash, white oak.
33E: Vanmeter	5c	Severe	Severe	Severe	Severe	White oak	45	Eastern white pine, white oak.
44: Bremer	3w	Slight	Severe	Moderate	Moderate	Eastern cottonwood Silver maple	90 80	American sycamore, green ash, eastern cottonwood, silver maple.
51: Kennebec	2o	Slight	Slight	Slight	Slight	Black walnut Bur oak Hackberry Green ash Eastern cottonwood	79 63 --- --- ---	Black walnut, green ash, eastern cottonwood, American sycamore.
58: Wabash	4w	Slight	Severe	Severe	Severe	Pin oak	75	Pin oak, pecan, eastern cottonwood.
66: Nodaway	2o	Slight	Slight	Slight	Slight	White oak	65	Eastern white pine, black walnut.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
6B Sharpsburg	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
10C2 Lagonda	---	Amur honeysuckle, Washington hawthorn, Amur privet, arrowwood, eastern redcedar, Tatarian honeysuckle, American cranberrybush.	Austrian pine, osageorange, green ash.	Pin oak, eastern white pine.	---
11B, 11C, 12B2, 12C2 Grundy	---	Washington hawthorn, Tatarian honeysuckle, Amur honeysuckle, Amur privet, American cranberrybush, arrowwood, eastern redcedar.	Austrian pine, osageorange, green ash.	Pin oak, eastern white pine.	---
13C2 Clarinda	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Amur honeysuckle, Tatarian honeysuckle, American cranberrybush.	Green ash, osageorange, Austrian pine.	Eastern white pine, pin oak.	---
14C, 15C2 Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
16D, 16E, 17D2, 17E2 Shelby	---	Silky dogwood, American cranberrybush, Amur honeysuckle, Amur privet.	Washington hawthorn, northern white-cedar, blue spruce, white fir.	Norway spruce, Austrian pine.	Pin oak, eastern white pine.
19C, 20C2 Ladoga	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
21D, 21E, 22D2, 22E2: Gara	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Northern white-cedar, white fir, Washington hawthorn, blue spruce.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
23C, 24C2: Armstrong	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Tatarian honeysuckle, Amur honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
25B, 26C2: Pershing	---	Eastern redcedar, Tatarian honeysuckle, Washington hawthorn, Amur privet, Amur honeysuckle, arrowwood, American cranberrybush.	Austrian pine, osageorange, green ash.	Eastern white pine, pin oak.	---
33E: Vanmeter	Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, osageorange, Russian-olive, Washington hawthorn.	Northern catalpa, honeylocust, green ash.	---	---
44: Bremer	---	Silky dogwood, Amur privet, Amur honeysuckle, American cranberrybush.	Norway spruce, Austrian pine, blue spruce, white fir, northern white-cedar, Washington hawthorn.	Eastern white pine	Pin oak.
45: Humeston	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern white-cedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
46: Arbela	---	Amur honeysuckle, Amur privet, American cranberrybush, silky dogwood.	Washington hawthorn, northern white-cedar, blue spruce, white fir, Austrian pine.	Norway spruce	Pin oak, eastern white pine.
51: Kennebec	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Eastern redcedar	Austrian pine, hackberry, pin oak, green ash, honeylocust.	Eastern white pine, eastern cottonwood.
52B: Olmitz	---	Amur honeysuckle, Amur privet, silky dogwood, American cranberrybush.	White fir, blue spruce, northern white-cedar, Washington hawthorn.	Austrian pine, Norway spruce.	Pin oak, eastern white pine.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
54----------------- Zook	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	Norway spruce, northern white-cedar, Austrian pine, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
55----------------- Colo	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, white fir, northern white-cedar, Washington hawthorn.	Eastern white pine	Pin oak.
56----------------- Nevin	---	Silky dogwood, Amur privet, American cranberrybush, Amur honeysuckle.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
57A---------------- Colo	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, white fir, northern white-cedar, Washington hawthorn.	Eastern white pine	Pin oak.
58----------------- Wabash	---	Amur honeysuckle, silky dogwood, Amur privet, American cranberrybush.	Norway spruce, Austrian pine, northern white-cedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
66----------------- Nodaway	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
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TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
6B Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
10C2 Lagonda	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Moderate: wetness.	Moderate: wetness.
11B Grundy	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
11C Grundy	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
12B2 Grundy	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
12C2 Grundy	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
13C2 Clarinda	Severe: percs slowly, wetness.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Moderate: wetness.	Moderate: wetness.
14C, 15C2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
16D Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
16E Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
17D2 Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
17E2 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
19C, 20C2 Ladoga	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
21D Gara	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
21E Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
22D2 Gara	Moderate: percs slowly, slope.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
22E2 Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
23C, 24C2------------- Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
25B------------------- Pershing	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight----------	Slight.
26C2------------------ Pershing	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Slight----------	Slight.
33E------------------- Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: large stones, slope, percs slowly.	Severe: slope.	Severe: slope.
44-------------------- Bremer	Severe: wetness, flooding.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
45-------------------- Humeston	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
46-------------------- Arbela	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
51-------------------- Kennebec	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
52B------------------- Olmitz	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
54-------------------- Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
55-------------------- Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
56-------------------- Nevin	Severe: flooding.	Moderate: wetness.	Moderate: wetness.	Slight----------	Slight.
57A------------------- Colo	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: flooding, wetness.	Severe: flooding.
58-------------------- Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
66-------------------- Nodaway	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
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TABLE 10.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
6B Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
10C2 Lagonda	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
11B Grundy	Fair	Good	Fair	Good	Good	Fair	Fair	Fair	Good	Fair.
11C Grundy	Fair	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
12B2 Grundy	Fair	Good	Fair	Good	Good	Fair	Fair	Fair	Good	Fair.
12C2 Grundy	Fair	Good	Fair	Good	Good	Poor	Very poor.	Fair	Good	Very poor.
13C2 Clarinda	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
14C, 15C2 Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
16D Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
16E Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
17D2 Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
17E2 Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
19C, 20C2 Ladoga	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
21D Gara	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
21E Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
22D2 Gara	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
22E2 Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
23C, 24C2 Armstrong	Fair	Good	Fair	Good	Fair	Very poor.	Poor	Fair	Good	Very poor.
25B Pershing	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
26C2 Pershing	Fair	Fair	Fair	Fair	Fair	Very poor.	Poor	Fair	Fair	Very poor.
33E Vanmeter	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.

TABLE 10.--WILDLIFF HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
44----------------- Bremer	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
45----------------- Humeston	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
46----------------- Arbela	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
51----------------- Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
52B---------------- Olmitz	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
54----------------- Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
55----------------- Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
56----------------- Nevin	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
57A---------------- Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
58----------------- Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Fair.
66----------------- Nodaway	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
88. Pits										

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
6B----------------- Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
10C2--------------- Lagonda	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
11B, 11C, 12B2, 12C2-------------- Grundy	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
13C2--------------- Clarinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
14C, 15C2---------- Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.	Moderate: wetness.
16D---------------- Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
16E---------------- Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
17D2--------------- Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
17E2--------------- Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
19C, 20C2---------- Ladoga	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
21D---------------- Gara	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
21E---------------- Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
22D2--------------- Gara	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
22E2--------------- Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
23C, 24C2---------- Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness.	Severe: low strength, frost action.	Moderate: wetness.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
25B, 26C2: Pershing	Severe: wetness.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.	Slight.
33E: Vanmeter	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
44: Bremer	Severe: wetness.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: wetness, shrink-swell, flooding.	Severe: low strength, frost action.	Moderate: wetness.
45: Humeston	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: wetness, low strength, frost action.	Severe: wetness.
46: Arbela	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
51: Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
52B: Olmitz	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
54: Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
55: Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
56: Nevin	Severe: wetness.	Severe: flooding.	Severe: wetness, flooding.	Severe: flooding.	Severe: frost action, low strength.	Slight.
57A: Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Severe: flooding.
58: Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.	Severe: wetness, too clayey.
66: Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
88. Pits						

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
6B: Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
10C2: Lagonda	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
11B: Grundy	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
11C: Grundy	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
12B2: Grundy	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
12C2: Grundy	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
13C2: Clarinda	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
14C, 15C2: Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
16D: Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
16E: Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
17D2: Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
17E2: Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
19C, 20C2: Ladoga	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
21D: Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
21E: Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
22D2 Gara	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
22E2 Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
23C, 24C2 Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
25B Pershing	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey.
26C2 Pershing	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey.
33E Vanmeter	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, hard to pack, slope.
44 Bremer	Severe: percs slowly, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
45 Humeston	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: wetness, too clayey.
46 Arbela	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
51 Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
52B Olmitz	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
54 Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
55 Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
56 Nevin	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
57A Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
58 Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.

TABLE 12.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
66------------------ Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
88. Pits					

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
6B-------------------- Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
10C2------------------ Lagonda	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
11B, 11C, 12B2, 12C2-- Grundy	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
13C2------------------ Clarinda	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
14C------------------- Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
15C2------------------ Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
16D------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
16E------------------- Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
17D2------------------ Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
17E2------------------ Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
19C, 20C2------------- Ladoga	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
21D------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope, small stones.
21E------------------- Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
22D2------------------ Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope, small stones.
22E2------------------ Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
23C, 24C2------------- Armstrong	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
25B------------------- Pershing	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
26C2------------------ Pershing	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
33E------------------ Vanmeter	Poor: area reclaim, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, slope.
44------------------ Bremer	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
45------------------ Humeston	Poor: low strength, shrink-swell, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
46------------------ Arbela	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
51------------------ Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
52B------------------ Olmitz	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
54------------------ Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
55------------------ Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
56------------------ Nevin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
57A------------------ Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
58------------------ Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
66------------------ Nodaway	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
88. Pits				

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
6B Sharpsburg	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
10C2 Lagonda	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Erodes easily, percs slowly.
11B, 11C, 12B2, 12C2 Grundy	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness.	Wetness, erodes easily.
13C2. Clarinda						
14C, 15C2 Lamoni	Moderate: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.
16D, 16E, 17D2, 17E2 Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
19C, 20C2 Ladoga	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.
21D, 21E, 22D2, 22E2 Gara	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
23C, 24C2 Armstrong	Moderate: slope.	Moderate: wetness, hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.
25B, 26C2 Pershing	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Wetness, erodes easily.	Erodes easily, percs slowly.
33E Vanmeter	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock, rooting depth.	Slope, depth to rock.	Slope, depth to rock.
44 Bremer	Slight	Severe: wetness, hard to pack.	Frost action	Wetness	Wetness	Wetness.
45 Humeston	Slight	Severe: wetness, hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Percs slowly, wetness.
46 Arbela	Slight	Severe: wetness, hard to pack.	Flooding, frost action.	Wetness, flooding.	Erodes easily, wetness.	Wetness, erodes easily.
51 Kennebec	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding	Favorable	Favorable.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
52B: Olmitz	Moderate: seepage, slope.	Slight	Deep to water	Slope	Favorable	Favorable.
54: Zook	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
55: Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
56: Nevin	Moderate: seepage.	Moderate: wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
57A: Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
58: Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
66: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
88. Pits						

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
6B----------------- Sharpsburg	0-15	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	15-33	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	33-46	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	46-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
10C2--------------- Lagonda	0-6	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	6-36	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	36-51	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	95-100	40-70	25-40
	51-60	Silty clay loam, silty clay, clay loam.	CL, CH	A-7	0	95-100	90-100	80-95	75-90	45-60	25-40
11B, 11C---------- Grundy	0-6	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-20
	6-16	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	25-35
	16-38	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	38-60	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
12B2, 12C2-------- Grundy	0-7	Silty clay loam	CH, CL	A-7	0	100	100	95-100	90-100	40-55	20-35
	7-12	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	90-100	45-55	25-35
	12-27	Silty clay-------	CH	A-7	0	100	100	95-100	90-100	50-70	30-45
	27-60	Silty clay loam	CH, CL	A-7	0	100	100	90-100	90-100	40-55	25-35
13C2--------------- Clarinda	0-9	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
	9-28	Silty clay, clay	CH	A-7	0	100	95-100	85-100	80-100	55-70	30-40
	28-60	Clay, silty clay	CH	A-7	0	95-100	95-100	80-95	75-90	55-70	35-45
14C---------------- Lamoni	0-7	Loam-------------	CL	A-6	0	95-100	95-100	80-95	70-95	25-40	10-20
	7-53	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	53-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
15C2--------------- Lamoni	0-6	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	6-54	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	54-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
16D, 16E---------- Shelby	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-33	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	33-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
17D2, 17E2-------- Shelby	0-8	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	8-30	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	30-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
19C---------------- Ladoga	0-8	Silt loam--------	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	8-46	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	46-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
20C2--------------- Ladoga	0-6	Silty clay loam	CL, CL-ML	A-6, A-4	0	100	100	100	95-100	25-40	5-15
	6-39	Silty clay loam, silty clay.	CL, CH	A-7	0	100	100	100	95-100	40-55	25-35
	39-60	Silty clay loam, silt loam.	CL	A-6	0	100	100	100	95-100	30-40	15-20
21D, 21E---------- Gara	0-10	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	10-41	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	41-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
22D2, 22E2-------- Gara	0-7	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	70-85	55-75	35-45	15-25
	7-40	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	40-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag-ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas-ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
23C----------------	0-11	Loam-------------	CL, CL-ML	A-6, A-4	0-5	90-100	80-95	75-90	55-80	20-30	5-15
Armstrong	11-36	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
	36-60	Clay loam---------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
24C2---------------	0-6	Clay loam---------	CL	A-6, A-7	0-5	90-100	80-95	75-90	55-80	35-45	15-25
Armstrong	6-34	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
	34-60	Clay loam---------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
25B----------------	0-14	Silt loam---------	CL	A-6	0	100	100	100	95-100	30-40	10-20
Pershing	14-36	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-65	20-40
	36-60	Silty clay loam, silt loam.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-55	20-35
26C2---------------	0-6	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	15-30
Pershing	6-30	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-65	20-40
	30-60	Silty clay loam, silt loam.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-55	20-35
33E----------------	0-6	Flaggy silty clay loam.	CL-ML, CL	A-4, A-6, A-7	5-15	95-100	75-100	70-100	65-100	25-45	5-20
Vanmeter	6-28	Silty clay loam, clay loam.	CL, CH	A-7	0-5	95-100	75-100	70-100	65-100	40-55	15-30
	28-60	Weathered bedrock	CH	A-7	0-5	95-100	90-100	90-100	85-100	65-80	50-60
44-----------------	0-16	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	45-60	25-40
Bremer	16-44	Silty clay loam, silty clay.	CH, MH	A-7	0	100	100	100	95-100	50-65	20-35
	44-60	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	40-60	25-40
45-----------------	0-13	Silt loam---------	CL, CL-ML	A-6, A-4	0	100	100	95-100	95-100	25-40	5-15
Humeston	13-22	Silt loam---------	CL, CL-ML	A-6, A-4	0	100	100	95-100	95-100	25-40	5-15
	22-60	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	95-100	45-55	25-35
46-----------------	0-12	Silt loam---------	CL-ML, CL	A-4, A-6	0	100	100	95-100	90-100	25-40	5-20
Arbela	12-21	Silt loam---------	CL-ML, CL	A-4, A-6	0	100	100	95-100	90-100	25-35	5-15
	21-45	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	20-30
	45-60	Silty clay loam	CL	A-6	0	100	100	95-100	90-100	30-40	15-25
51-----------------	0-49	Silt loam---------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
Kennebec	49-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
52B----------------	0-29	Loam, clay loam	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
Olmitz	29-60	Clay loam---------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
54-----------------	0-21	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
Zook	21-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
55-----------------	0-12	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
Colo	12-37	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	37-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
56-----------------	0-24	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	100	90-95	35-45	10-20
Nevin	24-50	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
	50-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
57A--------------- Colo	0-12	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	12-37	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	37-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
58---------------- Wabash	0-5	Silty clay--------	CH	A-7	0	100	100	100	95-100	50-75	30-50
	5-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
66---------------- Nodaway	0-60	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
88. Pits											

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
6B----------------	0-15	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	3-4
Sharpsburg	15-33	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	33-46	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
	46-60	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
10C2--------------	0-6	27-32	1.35-1.50	0.2-0.6	0.18-0.20	5.6-6.5	Moderate-----	0.37	2	7	.5-2
Lagonda	6-36	27-35	1.35-1.50	0.2-0.6	0.18-0.20	5.6-6.5	Moderate-----	0.37			
	36-51	35-50	1.30-1.40	0.06-0.2	0.13-0.18	5.6-7.3	High---------	0.37			
	51-60	35-45	1.30-1.40	0.06-0.2	0.10-0.18	6.6-7.8	High---------	0.37			
11B, 11C----------	0-6	12-27	1.35-1.50	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	3	6	2-4
Grundy	6-16	32-45	1.35-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High---------	0.37			
	16-38	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High---------	0.37			
	38-60	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High---------	0.37			
12B2, 12C2--------	0-7	28-35	1.35-1.45	0.2-0.6	0.18-0.20	5.6-7.3	High---------	0.37	2	6	.5-2
Grundy	7-12	32-45	1.35-1.45	0.2-0.6	0.18-0.20	5.6-6.5	High---------	0.37			
	12-27	40-50	1.30-1.40	0.06-0.2	0.11-0.13	5.1-7.3	High---------	0.37			
	27-60	28-35	1.35-1.40	0.06-0.2	0.18-0.20	5.6-7.3	High---------	0.37			
13C2--------------	0-9	30-38	1.45-1.50	0.2-0.6	0.17-0.19	5.1-7.3	Moderate-----	0.37	3	7	3-4
Clarinda	9-28	40-60	1.45-1.60	<0.06	0.14-0.16	5.1-6.5	High---------	0.37			
	28-60	40-60	1.55-1.75	<0.06	0.14-0.16	5.6-7.3	High---------	0.37			
14C---------------	0-7	22-27	1.40-1.45	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	3	6	3-4
Lamoni	7-53	38-50	1.55-1.75	0.06-0.2	0.13-0.17	5.1-6.5	High---------	0.32			
	53-60	32-40	1.75-1.85	0.06-0.2	0.14-0.18	5.6-7.3	High---------	0.32			
15C2--------------	0-6	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	2	7	2-3
Lamoni	6-54	38-50	1.55-1.75	0.06-0.2	0.13-0.17	5.1-6.5	High---------	0.32			
	54-60	32-40	1.75-1.85	0.06-0.2	0.14-0.18	5.6-7.3	High---------	0.32			
16D, 16E----------	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate-----	0.28	5	6	3-4
Shelby	7-33	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	33-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
17D2, 17E2--------	0-8	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28	4	6	2-3
Shelby	8-30	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	30-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
19C---------------	0-8	18-27	1.30-1.35	0.6-2.0	0.22-0.24	6.1-7.3	Low----------	0.32	5	6	2-3
Ladoga	8-46	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	46-60	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
20C2--------------	0-6	28-35	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.32	4	6	1-2
Ladoga	6-39	36-42	1.30-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	39-60	24-32	1.35-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
21D, 21E----------	0-10	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	2-3
Gara	10-41	25-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.28			
	41-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
22D2, 22E2--------	0-7	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.6-7.3	Moderate-----	0.28	4	6	1-2
Gara	7-40	25-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.28			
	40-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
23C---------------	0-11	22-27	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	3	6	2-3
Armstrong	11-36	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High---------	0.32			
	36-60	30-36	1.55-1.75	0.2-0.6	0.14-0.16	5.1-7.3	Moderate-----	0.32			
24C2--------------	0-6	27-38	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate-----	0.32	2	6	1-2
Armstrong	6-34	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High---------	0.32			
	34-60	30-36	1.55-1.75	0.2-0.6	0.14-0.16	5.1-7.3	Moderate-----	0.32			

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
25B--------------- Pershing	0-14 14-36 36-60	20-27 35-48 24-40	1.30-1.40 1.35-1.45 1.35-1.50	0.6-2.0 0.06-0.2 0.2-0.6	0.22-0.24 0.18-0.20 0.18-0.20	4.5-7.3 5.1-6.0 5.1-6.5	Low----------- High---------- High----------	0.37 0.37 0.37	3-2	6	2-3
26C2-------------- Pershing	0-6 6-30 30-60	27-38 35-48 24-40	1.30-1.40 1.35-1.45 1.35-1.50	0.2-0.6 0.06-0.2 0.2-0.6	0.22-0.24 0.18-0.20 0.18-0.20	4.5-7.3 5.1-6.0 5.1-6.5	Moderate------ High---------- High----------	0.37 0.37 0.37	3-2	7	1-2
33E--------------- Vanmeter	0-6 6-28 28-60	24-34 27-40 40-75	1.35-1.50 1.30-1.40 1.70-1.90	0.2-0.6 0.2-0.6 <0.06	0.14-0.16 0.14-0.16 0.08-0.10	6.1-8.4 6.1-8.4 7.4-8.4	Moderate------ Moderate------ High----------	0.32 0.32 ----	3	8	1-2
44---------------- Bremer	0-16 16-44 44-60	25-32 35-42 32-38	1.25-1.30 1.30-1.40 1.40-1.45	0.6-2.0 0.2-0.6 0.2-0.6	0.21-0.23 0.15-0.17 0.18-0.20	5.6-7.3 5.6-6.5 5.6-6.5	Moderate------ High---------- High----------	0.28 0.28 0.28	5	6	5-7
45---------------- Humeston	0-13 13-22 22-60	24-30 20-26 30-48	1.35-1.40 1.30-1.35 1.35-1.50	0.2-2.0 0.2-2.0 <0.06	0.21-0.23 0.20-0.22 0.13-0.15	5.1-7.3 4.5-6.0 4.5-6.5	Moderate------ Moderate------ High----------	0.32 0.32 0.32	4	6	3-4
46---------------- Arbela	0-12 12-21 21-45 45-60	20-30 18-27 35-40 27-36	1.30-1.50 1.35-1.55 1.30-1.40 1.30-1.40	0.6-2.0 0.6-2.0 0.2-0.6 0.2-0.6	0.20-0.22 0.20-0.22 0.18-0.20 0.18-0.20	6.1-7.3 5.1-6.5 4.5-5.5 5.1-6.0	Low----------- Low----------- Moderate------ Moderate------	0.32 0.43 0.43 0.43	5	6	2-4
51---------------- Kennebec	0-49 49-60	22-30 24-28	1.25-1.35 1.35-1.40	0.6-2.0 0.6-2.0	0.22-0.24 0.20-0.22	5.6-7.3 6.1-7.3	Moderate------ Moderate------	0.32 0.43	5	6	5-6
52B--------------- Olmitz	0-29 29-60	24-30 28-34	1.40-1.45 1.45-1.55	0.6-2.0 0.6-2.0	0.19-0.21 0.15-0.17	5.6-7.3 5.1-6.5	Moderate------ Moderate------	0.28 0.28	5	6	3-4
54---------------- Zook	0-21 21-60	32-38 36-45	1.30-1.35 1.30-1.45	0.2-0.6 0.06-0.2	0.21-0.23 0.11-0.13	5.6-7.3 5.6-7.8	High---------- High----------	0.28 0.28	5	7	5-7
55---------------- Colo	0-12 12-37 37-60	27-32 30-35 25-35	1.28-1.32 1.25-1.35 1.35-1.45	0.6-2.0 0.6-2.0 0.6-2.0	0.21-0.23 0.18-0.20 0.18-0.20	5.6-7.3 5.6-7.3 6.1-7.3	High---------- High---------- High----------	0.28 0.28 0.28	5	7	5-7
56---------------- Nevin	0-24 24-50 50-60	26-29 30-35 25-36	1.30-1.35 1.30-1.40 1.40-1.45	0.6-2.0 0.6-2.0 0.6-2.0	0.21-0.23 0.18-0.20 0.18-0.20	5.6-7.3 6.1-6.5 6.6-7.3	Moderate------ Moderate------ Moderate------	0.32 0.43 0.43	5	7	4-6
57A--------------- Colo	0-12 12-37 37-60	27-32 30-35 25-35	1.28-1.32 1.25-1.35 1.35-1.45	0.6-2.0 0.6-2.0 0.6-2.0	0.21-0.23 0.18-0.20 0.18-0.20	5.6-7.3 5.6-7.3 6.1-7.3	High---------- High---------- High----------	0.28 0.28 0.28	5	7	5-7
58---------------- Wabash	0-5 5-60	40-46 40-60	1.25-1.45 1.20-1.45	<0.06 <0.06	0.12-0.14 0.08-0.12	5.6-7.3 5.6-7.8	Very high----- Very high-----	0.28 0.28	5	4	2-4
66---------------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate------	0.37	5	6	2-3
88. Pits											

TABLE 17.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
6B----------------- Sharpsburg	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
10C2--------------- Lagonda	C	None---------	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	High-----	High-----	Low.
11B, 11C, 12B2, 12C2--------------- Grundy	C	None---------	---	---	1.0-3.0	Perched	Mar-May	>60	---	High-----	High-----	Moderate.
13C2--------------- Clarinda	D	None---------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	High-----	High-----	Moderate.
14C, 15C2---------- Lamoni	C	None---------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	Moderate	High-----	Moderate.
16D, 16E, 17D2, 17E2--------------- Shelby	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
19C, 20C2---------- Ladoga	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
21D, 21E, 22D2, 22E2--------------- Gara	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
23C, 24C2---------- Armstrong	C	None---------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	High-----	High-----	Moderate.
25B, 26C2---------- Pershing	C	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
33E---------------- Vanmeter	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High-----	Low.
44----------------- Bremer	C	Rare---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Moderate.
45----------------- Humeston	C	Rare---------	---	---	0-1.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
46----------------- Arbela	C	Occasional	Brief-----	Feb-Jul	0-1.5	Perched	Nov-May	>60	---	High-----	High-----	Moderate.
51----------------- Kennebec	B	Occasional	Brief-----	Feb-Jul	3.0-5.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
52B---------------- Olmitz	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
54----------------- Zook	C	Occasional	Brief to long.	Nov-Jul	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
55----------------- Colo	B	Occasional	Very brief to long.	Feb-Jul	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
56----------------- Nevin	B	Rare---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
57A---------------- Colo	B	Frequent----	Very brief to long.	Feb-Jul	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
58----------------- Wabash	D	Occasional	Brief to long.	Nov-Jul	0-1.0	Apparent	Nov-May	>60	---	Moderate	High-----	Moderate.
66----------------- Nodaway	B	Occasional	Very brief or brief.	Nov-Jul	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
88. Pits												

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Arbela	Fine, montmorillonitic, mesic Argiaquic Argialbolls
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Bremer	Fine, montmorillonitic, mesic Typic Argiaquolls
*Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Grundy	Fine, montmorillonitic, mesic Aquic Argiudolls
Humeston	Fine, montmorillonitic, mesic Argiaquic Argialbolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Ladoga	Fine, montmorillonitic, mesic Mollic Hapludalfs
*Lagonda	Fine, montmorillonitic, mesic Aquic Argiudolls
Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Nevin	Fine-silty, mixed, mesic Aquic Argiudolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Pershing	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Vanmeter	Fine, illitic, mesic Typic Eutrochrepts
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

* The soil is a taxadjunct to the series. See text for description of those characteristics of the soil that are outside the range of the series.

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